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Nobel Laureates, Industry Leaders Petition President to Boost Science and Technology

Sixteen Nobel Laureates in Physics and sixteen industry leaders have written to President George W. Bush to urge increasing funding for physical sciences, environmental sciences, mathematics, computer science and engineering.

The letter, reinforcing a recent Council of Advisors on Science and Technology report, highlights serious funding problems in the physical sciences and related fields that "unless remedied, will affect our scientific and technological leadership, thereby affecting our economy and national security."

The letter, which is dated April 14th, also indicates that "the growth in expert personnel abroad, combined with the diminishing numbers of Americans entering the physical sciences, mathematics and engineering—an unhealthy trend—is leading corporations to locate more of their R&D activities outside the United States."

Noting that NSF funding is only a small fraction of support for these fields, the co-signatories call for "a Presidential initiative for FY 2005, following on from your budget of FY 2004, and focusing on the long-term research portfolios of DOE, NASA, and the Department of Commerce, in addition to NSF and NIH," that, "would turn around a decade-long decline that endangers the future of our nation."

The lead signers of the letter were Burton Richter, director emeritus of SLAC, and Craig Barett, CEO of Intel Corporation.

Co-signatories to the letter coordinated their statement through the APS and the National Association of Manufacturers.

Nuclear Testing Not Necessary, Says New Council Statement

In a strongly worded statement passed at its April meeting, the APS Council reaffirmed its position that nuclear testing is not necessary to maintain the reliability of the American nuclear stockpile, and cited possible negative international consequences if nuclear testing were resumed.

Council also called on the Administration to provide sufficient advance notice of plans to resume testing, in order "to allow adequate time for informed and thorough analysis and public discussion".

In passing the statement, Council referred to a 2002 study by a committee of the National Academy of Sciences, which concluded that "the United States has the technical capabilities to maintain confidence in the safety and reliability of its existing nuclear-weapon stockpile" without nuclear testing, "provided that adequate resources are made available to the Department of Energy's nuclear-weapon complex and are properly focused on this task."

The full text of the Council statement follows:

The American Physical Society reaffirms its April 1997 statement that "fully informed technical studies have concluded continued testing is not required to retain confidence in the safety and reliability of the remaining nuclear weapons in the United States' stockpile."

Resumption of nuclear testing may have serious negative international consequences, particularly on the nonproliferation regime.

In addition the Society strongly urges the Congress and the Administration to provide sufficient notification and justification for any proposed nuclear test to allow adequate time for informed and thorough analysis and public discussion.

Consortia Provide Alternatives To Standard Journal Subscriptions

By Pamela Zerbinos

There is a saying in the world of scientific journals that is something of a cliché: "The subscription model is broken".

What broke it is rather up in the air. The rise of the Information Age and the accompanying public perception that information should be readily—and cheaply—available may have had something to do with it. The print journals keep getting larger and more numerous and libraries are simply running out of space in which to keep them. Meanwhile, publishing costs have been rising and numbers of subscriptions have been dropping.

Subscriptions to the APS's journals have been declining at a steady rate of 3.5% per year for about 30 years. The APS, which publishes eight journals, has been forced to raise subscription prices year after year, and although there has been an effort made to keep the increases in the single digits, it hasn't always happened that way. For 2004, subscriptions prices will be up an average of 8.7%.

Physics journals are not the only ones experiencing this phenomenon. A recent study by the University of Maryland Health and Human Services Library found that the average price of biology, chemistry, psychology, anthropology and other journals has increased nearly threefold since 1992. A recent *Harper's Index* (March 2003) claims that the average price for a US scientific, medical or technical journal has increased 250% since 1988.

As prices have climbed, the burden for paying the publishing costs has shifted away from large research institutions to smaller schools, less able to carry that burden. Several trends are responsible for this phenomenon, including the elimination of page charges (traditionally paid by research institutions) brought about by the direct competition of commercial physics journals; and the cancellations of multiple subscriptions at large institutions due to the electronic availability of the APS journals.

The APS has taken several steps in an effort to achieve a fair distribution of costs between major research-active subscribers, small undergraduate institutions, and those in between, including multi-tier pricing and the consortium model of journal subscriptions.

The consortium model has been growing quickly. It was pioneered by commercial publishers such as Academic Press and Elsevier, and now offered by many of the major academic publishers. APS along with the American Institute of Physics have been making consortium arrangements with government, corporate, and academic institutions, both domestically and internationally, for the past couple of years.

"The consortium model is really

See CONSORTIA *on page 6*

April Meeting Prizes & Awards

Photo Credit: Stacy Edmonds of Edmonds Photography

Prizes and Awards were presented to seventeen recipients at the April meeting in Philadelphia.

After the ceremony, recipients and their guests gathered at the Franklin Institute for a special reception.

The top photo shows four of the five women recipients in front of a space-suit exhibit. They are (l to r): Geralyn "Sam" Zeller (Tanaka Award); Chung-Pei Michele Ma (Maria-Goeppert Mayer Award); Yvonne Choquet-Bruhat (Heineman Prize); and Helen Edwards (Wilson Prize). The fifth woman, Melba Phillips (Burton Award), was unable to be present.

Photo Credit: Stacy Edmonds of Edmonds Photography

In the bottom photo, Dudley Herschbach (left) converses with Ernest Bergmann and John Archibald Wheeler. Herschbach gave a public lecture on "Ben Franklin's Scientific Amusements" immediately following the reception. Wheeler (right) shared the Einstein Prize, given for the first time this year, with the late Peter G. Bergmann, father of Ernest Bergmann.

Multimedia Plenary Lectures Posted on APS Site

With technical assistance from the University of Michigan, the APS has posted eight of the nine plenary lectures from the April meeting on the web. They can be accessed at http://www.aps.org/meet/archives/multimedia.html.

The audio from each lecture is synchronized with the slides that the speaker used. A video image of the speaker completes the presentation.

"This is the current state of the art in web lecture capture," said Alan Chodos, APS associate executive officer.

He noted that the audio and slides for most of the talks were captured automatically using software developed at the University of Michigan. Only when the speaker used transparencies instead of Powerpoint did the synchronization have to be done by hand.

Plans are underway to develop more sophisticated techniques for web lecture capture that will automate the process still further and will allow even lectures with transparencies to be automatically synchronized.

Chodos also noted that capturing lectures at an APS meeting presents some special challenges. "We are working at a remote location," he said, "so it's not possible to set up much before the lectures begin. We can't fine-tune the electronics and the lighting ahead of time."

At the April meeting, a team of three people, two from APS and one from Michigan, was on hand to capture the lectures. The new techniques that are currently being developed should help to reduce this number.

With the 2003 April meeting, APS is ending its experimental phase of web lecture capture, which began with a special session

See Multimedia *on page 7*

Results from LIGO'S First Run Reported at APS April Meeting

Radio, optical, x-ray, infrared and gamma-ray telescopes look at the universe via electromagnetic waves. For viewing the universe via gravity waves, the most sensitive telescope to date is the Laser Interferometer Gravitational-Wave Observatory (LIGO).

At the APS April meeting in Philadelphia, PA, scientists from the collaboration reported on the first official results from LIGO's initial science run, conducted over 17 days in September 2002.

Gravitational waves are intrigu-

See LIGO *on page 7*

Highlights

Members in the Media

"Higher bat speed generally means the ball comes off the bat faster."
—Alan M. Nathan, University of Illinois, on why baseballs travel farther when hit with aluminum bats, Baltimore Sun, April 21, 2003

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"Runners tend to lean somewhat forward, and to go from a somewhat forward lean in the run to a headfirst dive has a certain efficiency."
—Robert K. Adair, Yale University, on why a headfirst slide might be more efficient, Newsday, April 22, 2003

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"Pulsed power electrical systems have always been energy rich but power poor. That is, we can deliver a lot of energy, but it wasn't clear we could concentrate it on a small-enough area to create fusion. Now it seems clear we can do that."
—Ramon J. Leeper, Sandia National Laboratories, on recent results from Sandia's Z-machine, Albuquerque Tribune, April 7, 2003

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"We are eager to see what [LIGO's] future detections will reveal, as the instrument attains its full design sensitivity over the next couple of years."
—Lee Samuel Finn, Pennsylvania State University, SPACE.com, April 7, 2003

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"What we're trying to do is find where charge symmetry comes from."
—Edward Stephenson, Indiana University, on the observation of a pi-zero produced in deuterium fusion, Indiana Daily Student, April 4, 2003

"I did not like blood and gore."
—Vina A. Punjabi, Norfolk State University, on why she chose physics over biology, The Virginian-Pilot, April 6, 2003

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"It turns out the effect depends only on the velocity of the moving object — in this case Jupiter."
—Clifford Will, Washington University, on whether the speed of gravity has been measured, UPI Science News, April 7, 2003

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"The motion of dark matter can also be described statistically by a similar equation used for the Brownian motion. This equation is very different from Newton's law [of gravity] used in the computer model. This doesn't mean Newton's law is not applicable — it means the new equation that we found provides a new language for describing how dark matter clumps."
—Chung-Pei Ma, University of California, Berkeley, on how dark matter clumps in galaxy formation, SPACE.com, April 15, 2003

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"We use a 14-inch and a 24-inch telescope. We plan to beta test another 14-inch telescope in Chile, which may come online in fall 2003. This will open to us the Southern Hemisphere sky."
—Ron Armale, Cypress College, on how students use campus computers to operate telescopes remotely, Orange County Register, March 31, 2003

Blume is Co-Recipient of Compton Award

APS Editor-in-Chief Martin Blume has been awarded the 2003 Arthur H. Compton Award by Argonne National Laboratory's Advanced Photon Source facility, along with L. Doon Gibbs, Kazumichi Namikawa, and Denis B. McWhan.

Intended to recognize an important technical or scientific accomplishment at, or beneficial to, the photon source, the award honors these men for "pioneering theoretical and experimental work in resonant magnetic x-ray scattering, which has led to important applications in condensed matter physics."

Photo Credit: Bob Kelly

Martin Blume

Magnetic resonance scattering was first predicted in 1985 by Blume in a seminal theoretical paper in the *Journal of Applied Physics*, in which he derived the magnetic scattering cross section in a quantum mechanical formalism readily understandable by experimentalists. The effect was

See COMPTON AWARD *on page 3*

This Month in Physics History

June 1931: Lawrence and the First Cyclotron

The 1920s marked the transition of the U.S. to a modern technology-based society, and was also a period of momentous individual achievement. In the world of science, a 27-year-old physics professor in Berkeley, California, began the work that would launch a modern era of multidisciplinary national laboratories.

Ernest Orlando Lawrence was born in August 1901 in a small town on the South Dakota prairie to parents of Norwegian ancestry. As a teenager he tinkered with radios, entering St. Olaf College in Minnesota at 16. After a year, he transferred to the University of South Dakota, where a professor of electrical engineering convinced him that his interest in radio would be well-directed towards a career in physics rather than medicine. After graduating with honors in 1922, he pursued advanced studies at the University of Minnesota with W.F.G. Swann, whom Lawrence followed to the University of Chicago and then to Yale, where he completed his PhD in 1924 with a dissertation on the photoelectric effect. Lawrence stayed on at Yale as a postdoctoral fellow, continuing his research on photoelectricity, and started work on how atoms of a gas struck by electrons are ionized.

In 1928, Lawrence joined the faculty of the University of California, Berkeley, with a position that included connections to UCB's Chemistry Department. This access to scientists and students from other disciplines was critical to Lawrence's success as a researcher and established the pattern for the unique laboratory he subsequently created.

Inspired by a paper from Norwegian engineer Rolf Wideroe, Lawrence invented a unique circular particle accelerator which became known as the cyclotron. Wideroe's concept was based on using the same electrical potential twice, doubling the energy by switching from positive to negative potential in order to push ions and then to pull them. Lawrence judged Wideroe's linear scheme impractical for light atomic particles, since it would require a vacuum tube several meters long. But it inspired him to think about how one could use the same potential multiple times instead of just once. He conceived of using a magnetic field to bend charged particles into circular trajectories and thus pass them through the same accelerating region over and over again.

Above photo is Lawrence and Livingston around 1933, along with a photo of the Table-top cyclotron.

The idea required a combination of sophisticated techniques: a high-vacuum chamber with electric fields varying at radio frequencies and with some means to keep the particles in a single horizontal plane. The first such device was a pie-shaped concoction of gas, sealing wax and bronze that also incorporated a kitchen chair and a wire clothes tree for operation. This prototype proved the concept worked.

Completed in the summer of 1931, the accelerating chamber of the first cyclotron measured five inches in diameter and boosted hydrogen ions to an energy of 80,000 electron volts. His assistants subsequently constructed the 11-inch cyclotron, which broke the one million electron volt (MeV) barrier, but Lawrence was already dreaming of constructing a cyclotron with an accelerating chamber 27 inches in diameter and capable of reaching energies of nearly 5 MeV. In need of more laboratory space, Lawrence procured from the university an empty building adjacent to the physics department in August 1931, which he renamed the Radiation Laboratory, or the "Rad Lab."

The 27-inch accelerating chamber of the Rad Lab's first cyclotron was soon replaced with a 37-inch chamber with an acceleration capacity of 8 MeV for deuterons and 16 MeV for alpha particles. By 1936 the machine had been used to create radioisotopes and the first artificial element, technetium. Around this time, Lawrence invited his brother, John, a physician, to join the lab and explore the use of radioisotopes in biology and medical research, culminating in the construction of the Crocker Lab, with an accelerating chamber measuring 60 inches in diameter. It began operation in 1939. That same year, Lawrence was awarded the Nobel Prize in Physics in recognition of his revolutionary device.

Lawrence's next cyclotron featured a magnet weighing 4,000 tons and an accelerating chamber 184 inches in diameter, capable of accelerating atomic particles to energies in excess of 100 MeV. To house the machine and experimental facilities needed to go with it, a permanent site for the Rad Lab was constructed on nearby Charter Hill, completed in 1946.

The development of Lawrence's cyclotron helped change our understanding of nature, from the microscopic structure of matter to human metabolism, from the process of photosynthesis to the creation of new chemical elements, including number 103 (lawrencium). Lawrence also created the model of the big-science laboratory, two of which bear his name: the Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory. Lawrence's labs have pushed the interdisciplinary approach into such fruitful new fields as environmental research, alternative energy sources, astrophysics, and molecular biology. Lawrence died on August 27, 1958, of chronic colitis at the age of 57.

Adapted in part from an online exhibit by the American Institute of Physics History Center, "The Legacy of E.O. Lawrence." See http://www.aip.org/history/lawrence/ *for the full exhibit.*

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Number Three

Ground State of the Electron Gas by a Stochastic Method

(D. M. Ceperley and B. J. Alder, Phys. Rev. Lett. 45 (1980) 566), 3548 citations

This is the eighth in a series of articles by James Riordon. The first article appeared in the November 2002 issue. The articles are archived under "Special Features" on the APS News online web site.

Although the paper "Ground State of the Electron Gas by a Stochastic Method" is third in our list of the ten most highly cited *Physical Review Letters*, David Ceperley has one regret regarding the work he co-authored with computational physics legend Berni Alder, "Well, the letter was so successful that I never wrote the long paper," says Ceperley. "That was a mistake actually. I thought I should have been able to do a better job, but it was harder than I thought to improve on it." For Alder, on the other hand, choosing not to follow up on the paper with a longer *Physical Review* submission was in keeping with his lifelong approach to physics. "I like to find the new problems and skim the cream off the top," laughs Alder, "and I think we really creamed that one. After I finish a problem, I like to move on."

The cream, in this particular case, was the first important application of a type of quantum many-body algorithm now known as the Quantum Diffusion Monte Carlo method, or quantum DMC. Ceperley and Alder applied DMC to determine the properties of electron gases at intermediate densities.

Previous work had led to solutions to the problem at high and low electron densities. But other than crude estimates by the likes of Eugene Wigner and others dating back to the 1930s, the problem of intermediate densities had lingered for more than half a century.

"The basic bosonic algorithm was developed by Malvin Kalos, my thesis advisor, and we partially extended it to fermions as part of my thesis in 1976" says Ceperley. "What I'd done as a postdoc was make it into a much more convenient and accurate form. Then the ground work paid off when I came to Berkeley and collaborated with Berni Alder. We had access to orders-of-magnitude more computing time than I had ever had before . . . except it was all behind the fence at Livermore."

Although Ceperley did not have a clearance he managed to run simulations, which required thousands of hours of computer time, through an intermediary. "I had to communicate my instructions to Alder's assistant, Mary Ann Mansigh, over the telephone. We'd spend half an hour talking every day and she would set up five or ten different runs for the evening. The next morning she would tell me what the results were, or mail me back the output." Surprisingly, Ceperley notes, "It was actually rather efficient after the algorithm was working."

By the time Ceperley arrived in California, Alder was already a renowned pioneer in computational physics and the author of at least two other highly cited papers. His previous work primarily centered on the classical dynamics of hard spheres, but in the late 1970s he was eager to tackle quantum many-body problems. "I have a knack for being at the right place at the right time," says Alder, "You have to sort of smell what are the right problems in physics. And I think I may have that smell. And you also must have the tools to follow through that smell, that's the key. In the early days, one of the tools was big computers, and in this case certainly big computers helped. It was also important to think about physics in a numerical way, differently than people who did not have big computers."

To solve the electron gas problem, the researchers began with a restricted, fixed-node problem.

"The node," explains Alder, "is where the wave function goes from positive to negative. And if you knew the nodes exactly you could solve the quantum Monte Carlo problem exactly." Generally, however, the exact nodes are unknown and the researchers must guess where they might lie from some approximate theory.

To determine their true position, the researchers release the nodes so that they can shift about and lower the energy of the system. In an electron gas, the energy converges nicely and the equilibrium solution can be precisely determined. For more complex systems, DMC is plagued by an instability known as the fermion sign problem. "The fermion wave function has, of course, a positive and a negative part," says Alder. "When you release the nodes you allow both the negative and positive part to exponentially grow."

Despite the instability, DMC is still useful provided that a system's boson energy and fermion energy are comparable. In such cases says Alder, the answer appears as the difference between the positive and negative populations in the calculation, if the two portions of the solution don't grow too quickly. "But if you go to other systems," says Alder, "like chemical systems where the difference between the fermi energy and the boson energy is very large, you can no longer accurately project out the difference." The fermion sign instability is one of the outstanding problems in computational physics.

Nonetheless, DMC is one of a handful of quantum many-body methods that Alder and Ceperley say can apply in principle to any equilibrium quantum problem. "Whenever you want to calculate things ab initio," says Ceperley, "starting with the positions and charges of the nuclei, and with many electrons, then the state of the art is density functional theory. Density functional theorists use the electron gas result because they are perturbing their system about the uniform electron system."

Ceperley is now a faculty member in the physics department and a researcher with the National Center for Supercomputing Applications at the University of Illinois, where he spends some of his time searching for solutions to DMC instabilities.

Alder is retired from Livermore, but is keeping his hand in as well, working on the problem part-time with Ceperley's former thesis advisor, Malvin Kalos. Alder, however, is primarily interested these days in extending molecular dynamics to help explain the origin of hydrodynamic turbulence on molecular scales.

Strangely enough, unlike other powerful methods that made our top ten PRL list, quantum DMC is not named after the researchers who were so instrumental in its development. "There have been a fairly large number of contributions to the problem," says Alder, "which distributes the credit."

Nevertheless, Ceperley chuckles when he admits that he was able to leave one personal and indelible mark on the method, "I did manage to embed my initials in the acronym." DMC, it happens, also stands for David M. Ceperley.

April Teachers' Day

Photo Credit: Edward Lee

Participant Boris Dirnbach and presenter Dave Smith try out a pinhole viewer at the APS High School Physics Teachers' Day in Philadelphia on April 7, 2003. Seventy-eight teachers attended research talks, took part in workshops, and also enjoyed lunch with physicists from the April meeting.

Council: There is No Free Lunch

"The American Physical Society deplores attempts to mislead and defraud the public based on claims of perpetual motion machines or sources of unlimited useful energy, unsubstantiated by experimentally tested established physical principles."

With this brief statement, passed by Council at its April meeting, the APS reaffirmed the applicability of the established laws of physics, and issued a warning to the public to beware of unscrupulous and misguided attempts to sell schemes that cannot work.

"Unlike those passed by legislative bodies, the laws of physics cannot be violated," said Bob Park, APS Director of Public Information. "Unfortunately, there are still people out there who raise scads of money by claiming to violate the laws of thermodynamics."

Park anticipated that the Council statement will prove useful to prosecutors in cases involving claims of perpetual motion.

He cited the case of Dennis Lee (see *What's New*, October 4, 2002, accessible from the APS web site). The judge, in ruling against Lee, quoted verbatim from an earlier resolution on perpetual motion that had been passed by the APS Executive Board.

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first observed experimentally by Namikawa and colleagues at the Photon Factory in Tsukuba, Japan.

Their work was carried out with synchrotron radiation tuned to energies close to the K absorption edge of nickel, and clearly demonstrated a resonantly enhanced magnetic cross section at that edge.

Large resonance enhancements, which put resonance scattering into the consciousness of the synchrotron community, were observed in 1988 at the Cornell High Energy Synchrotron Source by a team led by Gibbs and McWhan, and their ensuing paper on the subject had a profound influence and impact on the x-ray and magnetism communities, clearly establishing x-rays as a viable alternative to neutrons for the study of magnetic structure.

The technique has since blossomed to such an extent that every major synchrotron source in the world, including the Advanced Photon Souce, now has one or more beamlines dedicated to resonant magnetic scattering, an explosion driven in large part by the work of Blume, Gibbs, Namikawa, and McWhan.

Blume delivered the Compton invited lecture on behalf of all the award recipients at the opening session of the Advanced Photon Source's 12th User's Meeting on April 30. While expressing his delight at being honored with the award, Blume acknowledged the contributions of other deserving scientists who were omitted, most notably James Hannon and George Trammel.

"They are outstanding physicists who were very much responsible for a number of key ideas in the theory of resonance scattering, many of which were originated by them in papers on Mossbauer scattering by nuclei dating back to the 1960s," he said. "I do hope they will be recognized in the future for their many important contributions to these and other fields."

Viewpoint...

The Citizen-Scientist's Obligation to Stand Up for Standards

By Lawrence M. Krauss

On April 2, I appeared at a symposium for students and teachers sponsored by the Illinois Math and Science Academy, a remarkably successful high school founded by Dr. Leon M. Lederman, a Nobel laureate in physics, to foster young people's interest in science.

The symposium, called "Science, Technology and Society: Ethical Awareness for Tomorrow's Leaders," was convened to discuss the way ethical issues might be explicitly raised for young scientists.

I was somewhat hesitant to appear on a panel on ethics because, like almost all scientists I know, I have no formal training in this subject. Indeed, like many of my colleagues, I have been reluctant to include formal courses on ethics in the physics curriculum, and I have tended to suppose that students should learn the ethos of science "by example."

Presumably, in laboratory courses and in research projects with faculty, students can learn the values of honesty, creativity and full disclosure that are the hallmarks of good science. Also, in spite of the implicit hierarchy associated with education, students should get a sense of the "anti-authoritarianism" of science: that there are, or should be, no scientific authorities whose views are not subject to question.

Indeed, proving one's colleagues (and oneself) wrong is one of the great pleasures of scientific progress.

Scientific ethics have been mightily tested of late. In my own field of physics in the past several years, two important examples of scientific fraud were uncovered in subfields as diverse as molecular electronics and nuclear physics. In each case the fraudulent results were brought to light relatively quickly, but not before they were published in articles involving numerous co-authors who should have been more skeptical.

This lack of internal critical review has prompted much handwringing. It has also raised an issue of ethical responsibility: do scientists who take credit as co-authors of papers need to verify all of the results cited in those papers?

The problem is that by nature science does not deal well with fraud. Scientists assume some basic level of honesty in the scientific enterprise, and while we expect mistakes to occur, we do not anticipate deliberate obfuscation of the facts.

Moreover, scientists tend to expect that ultimately the truth will win out without explicit and immediate action on their part. Future experiments that do not reproduce earlier results will expose fraudulent experimentalists, while theoretical nonsense will be exposed when it leads to nonsensical predictions.

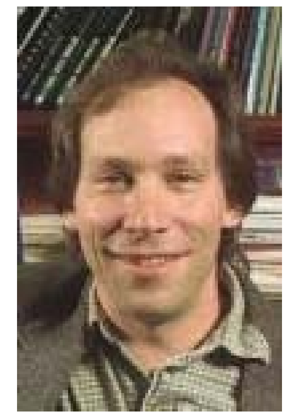
Nevertheless, scientists must not allow nonsense to remain unconfronted, regardless of whose sensibilities we offend. Once we allow empirical truth to be blurred with impunity in one important area of human activity, we jeopardize the very basis of a healthy democracy.

So I found myself in Chicago in early April proposing a possibly unpopular thesis: *scientists have a special ethical responsibility at this particular time to question our government's actions*.

It appears that this administration is marginalizing the recommendations of major scientific organizations on the one hand, while defending artificial "research" to support political goals, or, worse still, manufacturing it. Empirical constraints that may otherwise guide sensible policy making seem to be evaporating.

When a Bell Labs scientist was shown to have based some of his results on fraudulent data, his other scientific results, no matter how exciting, lost credence. We should be prepared to apply the same skepticism to the political arena.

In march, the National Academy of Sciences presented the reports of an expert panel that assessed current plans for examining the effects of global warming. The scientists concluded that the research program proposed by the administration lacked the most basic elements of a strategic research plan.



Lawrence M. Krauss

In particular, the panel said it lacked "a guiding vision, executable goals, clear timetables and criteria for measuring progress, an assessment of whether existing programs are capable of meeting these goals, explicit prioritization and a management plan." In short, it lacks the characteristics on which empirical science is based.

A year ago, the American Physical Society passed a resolution calling on the government to delay deployment of a missile defense system until it was demonstrated to be workable against realistic threats. Yet the administration scrapped a longstanding international treaty, committing billions of dollars to the deployment of a missile defense system that even under the most liberal interpretation of the data has a success rate of 40%.

We would not accept such innumerate policies in the private sector. What if Detroit put on the assembly line a new breed of SUV's that toppled over when executing curves at greater than 30 miles an hour 60% of the time, or if the makers of nuclear power reactors demonstrated that prototypes catastrophically failed 40% of the time?

Dr. Shirley Tilghman and Dr. David Baltimore, internationally known biologists, and the presidents respectively of Princeton and Caltech, wrote recently in *The Wall Street Journal* that human reproductive cloning and therapeutic cloning to produce stem cells that might be used for research were completely different biological investigations.

Further, they said a wholesale ban on cloning designed to stop efforts to produce the former would have dire consequences for important biological research on the latter.

Yet the White House has suported a wholesale ban on cloning, driven it seems by inappropriate fears of science.

Equally worrisome is what apparently is the distortion of the results of medical studies in government web sites, like the National Cancer Institute's.

It used to state that the best studies showed "no association between abortion and breast cancer," but was altered to say that the evidence was inconclusive until a scientific review panel insisted the original language, which correctly reflects current research, be reinstated.

Or consider the web page of the Centers for Disease Control and Prevention, which used to point to studies showing that education on condom use did not lead to earlier or increased sexual activity; now, it omits this discussion.

A democracy, like science, functions best only when all actions are open to question, and when we require the highest levels of accountability. If there is a risk that politics is being placed above empirical truth on issues of vital national importance, inaction by scientists may be unethical.

Lawrence Krauss is at Case Western Reserve University, and the author of several popular science books, including The Physics of Star Trek *and* Atom. *The above originally appeared in* The New York Times *on April 22, 2003. Reprinted with permission.*

Scientists Observe Charge Symmetry Breaking in Separate Experiments

In separate experiments at the Indiana University Cyclotron Facility (IUCF) and the TRIUMF cyclotron in Canada, researchers have made groundbreaking new measurements of charge symmetry breaking (CSB), according to results presented at the APS April meeting in Philadelphia.

Such measurements can provide deep insights into why nature gave the neutron and proton slightly different masses. At an even more fundamental level, the CSB measurements can potentially yield more precise values of the mass differences between the up and down quarks that make up protons and neutrons.

Nuclear theorists are busily analyzing these new experimental results to put tighter constraints on the up-down mass difference.

In the 1930s, Werner Heisenberg proposed that the neutron and proton are simply slightly different manifestations of the same particle, called the "nucleon." Modern nuclear physics endorses this view: plenty of nuclear reactions proceed exactly the same way if a proton takes the place of a neutron, or vice versa. However, this close similarity breaks down in some cases, leading to the phenomenon known as charge symmetry breaking.

One effect of this charge symmetry violation is that the neutron is slightly heavier than its charged partner, the proton. Thus, isolated neutrons decay into protons in about 10 minutes.

At the APS meeting, Ed Stephenson of Indiana University announced the first unambiguous identification of a rare process: the fusion of two nuclei of heavy hydrogen to form a nucleus of helium and an uncharged pion, one of the subatomic particles responsible for the strong force that binds nuclei together.

Over a two-month period, researchers observed this rare reaction several dozen times, giving physicists enough data to test theories of CSB.

"Scientists have searched for this rare fusion process since the 1950s," said Stephenson. "And the process would not happen at all if nature did not allow a small violation of charge symmetry." In fact, if the symmetry violation had occurred in other direction—that is, if the proton had been slightly heavier than the neutron—hydrogen would not have survived after the Big Bang, and the universe would not have the hydrogen fuel that keeps stars shining, including the sun, which makes human life possible. "Sometimes large consequences hang on delicate balances in nature," he said.

Representing a collaboration at TRIUMF, Allena Opper of Ohio University discussed the detection of CSB in another nuclear reaction: the fusion of a proton and neutron, which produces a charged pion as one of its products. Viewed from a perspective (or reference frame) in which the proton and neutron meet at the center, the reaction—repeated many times—produces a small excess of pions (about 0.17%) in a preferred direction. Such an asymmetry is a hallmark of CSB.

Taken together, these new CSB results promise a wealth of information on such things as the slightly different electromagnetic fields inside each nucleon. As it turns out, such fields may contribute to the proton-neutron mass difference, as they carry energy which converts into a small amount of mass. "The rate of the process will tell scientists how much of the violation comes from the fact that quarks carry small electrical charges, and how much comes from the difference in mass between the two types of quarks found inside neutrons and protons," said Stephenson.

Congressional Fellows Reminisce

Photo Credit: Jessica Clark

The APS Congressional Fellows program, which supports physicists who want to spend a year working in the office of a member of Congress, is 30 years old this year, and several past APS Fellows gathered at the April meeting to relive their year on the Hill and report on how it had affected their careers. Shown here participating in a panel discussion are (l to r): Ben Cooper (Fellow 1973-74); Rush Holt (1982-83); and Jane Alexander (1986-87). Holt (D-NJ) is one of two physics PhDs currently serving in Congress.

zero gravity
The Lighter Side of Science

Didja hear the One About.... Celebrating the Art of Bad Physics Jokes

The Odd Primes joke

There was a mad social scientist who kidnapped three colleagues, an *engineer*, a *physicist*, and a *mathematician*, and locked each of them in separate cells with plenty of canned food and water but no can opener.

A month later, returning, the mad scientist went to the *engineer's* cell and found it long empty. The engineer had constructed a can opener from pocket trash, used aluminum shavings and dried sugar to make an explosive, and escaped.

The *physicist* had worked out the angle necessary to knock the lids off the tin cans by throwing them against the wall. She was developing a good pitching arm and a new quantum theory.

The *mathematician* had stacked the unopened cans into a surprising solution to the kissing problem; his desicated corpse was propped calmly against a wall, and this was inscribed on the floor in blood:

Theorem: If I can't open these cans, I'll die.

Proof: Assume the opposite...

***

A *physicist*, an *engineer* and a *mathematician* were asked how much three times three is.

The *engineer* grabbed his pocket calculator, eagerly pressed a couple of buttons and announced: "9.0000".

The *physicist* made an approximation (with an error estimate) and said: "9.00 ± 0.02".

The *mathematician* took a piece of paper and a pencil and sat quietly for half an hour. He then proudly declared: 'There is a solution and I have proved that it is unique!'

***

A *physicist*, an *engineer* and a *mathematician* were all in a hotel sleeping when a fire broke out in their respective rooms.

The *physicist* woke up, saw the fire, ran over to her desk, pulled out her CRC, and began working out all sorts of fluid dynamics equations. After a couple minutes, she threw down her pencil, got a graduated cylinder out of his suitcase, and measured out a precise amount of water. She threw it on the fire, extinguishing it, with not a drop wasted, and went back to sleep.

The *engineer* woke up, saw the fire, ran into the bathroom, turned on the faucets full-blast, flooding out the entire room, which put out the fire, and went back to sleep.

The *mathematician* woke up, saw the fire, ran over to his desk, began working through theorems, lemmas, hypotheses , you-name-it, and after a few minutes, put down his pencil triumphantly and exclaimed, "I have "proven" that I "can" put the fire out!" He then went back to sleep.

***

In the high school gym, all the girls in the class were lined up against one wall, and all the boys against the opposite wall. Then, every ten seconds, they walked toward each other until they were half the previous distance apart.

A *mathematician*, a *physicist*, and an *engineer* were asked, "When will the girls and boys meet?"

The *mathematician* said: "Never."

The *physicist* said: "In an infinite amount of time."

The *engineer* said: "Well...in about two minutes, they'll be close enough for all practical purposes."

***

An *engineer*, a *physicist*, and a *mathematician* are shown a pasture with a herd of sheep, and told to put them inside the smallest possible amount of fence.

The *engineer* herds the sheep into a circle and then puts the fence around them, declaring, "A circle will use the least fence for a given area, so this is the best solution."

The *physicist* creates a circular fence of infinite radius around the sheep, and then draws the fence tight around the herd, declaring, "This will give the smallest circular fence around the herd."

The *mathematician* puts a small fence around himself and then declares, "I define myself to be on the outside!"

***

An *astronomer*, a *physicist* and a *mathematician* were holidaying in Scotland. Glancing from a train window, they observed a black sheep in the middle of a field.

"How interesting," observed the *astronomer*, "all Scottish sheep are black!"

To which the *physicist* responded, "No, no! Some Scottish

See **ZERO GRAVITY** *on page 6*

Physicist Disputes Speed of Gravity Claim

A experiment showing gravitational lensing by the planet Jupiter early this year was originally interpreted as providing a measurement of the speed of gravity, although the conclusion was controversial from the outset.

At the APS April meeting, Clifford Will of Washington University in St. Louis, Missouri, a leading theorist in the interpretation of general relativity, presented his own analysis, disputing the earlier claims.

On September 8, 2002, Jupiter passed within 3.7 arcminutes of quasar J0842+1835, the center of a distant galaxy and a strong source of radio waves.

Ed Fomalont, a researcher at the National Radio Astronomy Observatory in Charlottesville, VA, used atomic clocks and the "Very Long Baseline Array" of radio telescopes to measure the brief length of time by which radiation from a quasar was delayed as it passed by the planet Jupiter.

Fomalont's measurement showed that the gravitational influence of the moving planet delayed the radio waves by about 5 trillionths of a second, or bent the waves by less than 15 billionths of a degree.

According to the general theory of relativity, gravity must be propagated at the same speed as light: 186,000 miles per second. Therefore, measuring the speed of gravity would test Einstein's theory.

Using Fomalont's data, Sergei Kopeikin (University of Missouri, Columbia) inferred that the speed of gravity is indeed the same as that of light, although the margin of error was 20%

"They obtained a very beautiful experimental result, and I have no quarrel with that," said Will. "The issue is the interpretation of the measurement. I don't think this result says anything about the speed of gravity."

In a paper recently accepted for publication by the *Astrophysical Journal*, Will claims that although the experiment is capable of measuring the speed of gravity, the effect is too small to measure, and that the value presented by Kopeikin and Fomalont as the speed of gravity is actually the speed of light.

"When I did a detailed calculation that put gravity's speed at any value, the result for the delay of light was independent of gravity's speed," said Will. "It depended only on the speed of light. So it's not possible to determine the speed of gravity from these light-delay observations." That measurement will have to wait for the LIGO observatories to begin regularly detecting gravitational waves (see story, page 1).

Will also criticized the press for prematurely reporting the result and, to some extent, magnifying a simple scientific debate into a controversy.

"The press jumped on this in a rather uncritical way," he said. "Experimentally, it's really a *tour de force* measurement, which will be diminished somewhat by the controversy."

Five Takes on the Future of Particle Physics

By Pamela Zerbinos

For the first time, this year the annual meeting of the APS Division of Particles and Fields (DPF) was held in conjunction with the APS April meeting. To mark the occasion a special session on "The Future of Particle Physics" took place in the auditorium of the University of Pennsylvania's Museum of Archaeology and Anthropology. The five speakers gave differing but complementary views of what lies ahead in particle physics.

One of the talks at the session was the Primakoff Lecture, named in memory of Henry Primakoff, who coincidentally spent many years at the University of Pennsylvania. The Primakoff Lecture is an annual feature at the April meeting, and this year it was given by Michael Turner of the University of Chicago and Fermilab, on "Connecting Quarks to the Cosmos." Turner focused on the connections between particle physics and cosmology that promise to deepen in the coming years. Particulate dark matter, which constitutes one-third of the universe, is of concern to scientists of both disciplines, and tests will need to be performed in both terrestrial and heavenly laboratories.

Other opportunities for the fields to collaborate include the study of strong field gravity, ultra-high-energy cosmic rays, baryogenesis, and "extreme physics," which includes the study of black holes, plasmas and neutron stars.

The University of Michigan's Homer Neal discussed the Large Hadron Collider currently under construction at CERN. Over 3,500 physicists worldwide are involved in the LHC project, which is scheduled for completion in 2007.

Neal described the two big detectors, ATLAS and CMS, and highlighted the work of U.S. institutions in the project; currently the US has the highest percentage of contributing scientists and institutions. They are helping with everything from building machine components to acting as computing centers in the data grid that will do the processing of the petabytes of data expected to be produced once the LHC is up and running.

He also discussed some of the physics expected to come out of the LHC, including the search for the Higgs boson and for supersymmetric particles. Neal also touched on his own work in elastic scattering at high energies, which he hopes will be illuminated by the LHC, expected to reach a center of mass energy of 14 TeV.

Princeton's Peter Meyers spoke about the future of neutrino oscillation physics. The hottest experiment right now is MiniBooNE at Fermilab, set to confirm or refute the controversial results of the LSND collaboration at Los Alamos. A confirmation of the results could mean there is a fourth, sterile neutrino, whose existence would definitely require more than Standard Model physics. As results from the current round of neutrino experiments start to come in, a clear and consistent picture should start to emerge and point the way to the next generation of experiments. Meyers said he expects this will require larger, more capable detectors and more intense beams (His rallying cry of, "Bigger! Slower! More expensive!" drew laughs from the audience).

Natalie Roe, from the Lawrence Berkeley National Laboratory, focused her talk on CP violation. Although the latest results from the B physics experiments at SLAC and at KEK in Japan have found CP violation at the expected levels, thereby confirming the Standard Model one more time, increasingly precise measurements will be available soon. She stressed that the baryon asymmetry of the universe remains a mystery that is not explained in the context of CP violation in the Standard

See **PARTICLES** *on page 6*

LETTERS

That Old School of Mine…

I was surprised to see (*APS News*, April 2003, Vol. 12, No. 3) that the Nobel Prize winner, Irving Langmuir, graduated from the "Colarado" School of Mines in 1903 with BS in Metallurgical Engineering. We checked our records and he was not on our graduation list. We then checked an old Who's Who and found that he graduated from Columbia School of Mines in that year.

Don L. Williamson
Colorado School of Mines

Traitorous Translations

The discussion of the pitfalls of translation in "New Spanish Lab Manual Available for Physics Teachers" [*APS NEWS*, April 2003] struck a chord for me.

Some years ago, I co-authored a university physics text. The Spanish and Portuguese translations contained the usual number of translation errors, but I found one particularly amusing.

In the section on the physics of music, I had written, "A piece consisting entirely of consonances would be unbearably tedious, and the resolution of dissonances into consonances is a very important aspect of Western music."

In the Spanish translation, this reads, "*...es un aspecto muy interessante de la musica del Oeste norteamericano.*" Translated back into English, this reads, "*...is a very interesting aspect of cowboy music.*"

As the Italians say, *traduttore tradittore*: the translator is a traitor.

Lawrence S. Lerner
CSU, Long Beach

CONSORTIA *from page 1*

a response to an attempt to bring together people with a common interest in information to try and use resources more efficiently," said Tom McIlrath, APS treasurer.

The consortium model is based on historical subscription data, with an access fee added to the price of the sum of the original subscriptions. Participating members of the consortium gain online access to the specific titles or in most cases to expanded amount of content for relatively a small additional cost. Each consortium is different, and so is each deal.

"The consortium model, if it becomes pervasive, will have three effects," said Barbara Hicks, APS associate publisher and director of marketing. "It will hopefully allow APS to sustain its current revenue, provide a new revenue stream and make the APS journals more widely available. In many cases, the consortium model grants electronic journal access to smaller institutions that have not traditionally been able to afford subscriptions on their own."

Corporations can—and have—formed consortia to allow employees in various offices around the world to access the journals. Single universities wishing students on satellite campuses to have access can also form consortia.

After the deal is negotiated, each institution in the consortium is given online access to the APS journal titles as subscribed to. They have the option of converting from print plus online subscriptions to the electronic version and receive the appropriate discount (approximately 15% discount) any time during the agreement.

For consortia members, the model works best if they have outside funding. The APS' first consortium, *OhioLink*, comprises all the universities in Ohio and is subsidized by the state legislature.

By contrast, a different state without that outside source of funds would have a very difficult time getting all the universities to sign a consortium deal. The large universities likely already subscribe to all the APS journals and would therefore just be paying an additional fee to allow the smaller institutions access, which not all are willing to do.

Libraries of all sizes worldwide gain benefits from joining consortia by providing budgetary stability via multi-year contracts, price caps, and electronic access to expanded content for a small additional fee.

For APS, advantages have been realized from additional revenue streams, stable revenues over long license terms (usually three years), and stability of existing subscriptions because of the non-cancellation policies.

Consortia have another advantage, in support of the Society's mission, "to promote the advancement and diffusion of the knowledge of physics," as greater amounts of APS journal content are made available to a vastly expanded community.

Helen Quinn Elected to Membership In National Academy of Sciences

APS President-elect Helen Quinn has been elected to the National Academy of Sciences. She joins seventy-one other newly elected members this year, including APS members Praveen Chaudhary, Wendy L. Freedman, Sidney R. Nagel, Robert J. Silbey, Saul A.Teukolsky, Dale J.Van Harlingen, and Eli Yablonovitch.

Helen Quinn

Election to membership in the Academy is considered one of the highest honors that can be accorded a U.S. scientist, and is bestowed in recognition of distinguished and continuing achievements in original research.

Quinn, who has been on the permanent staff of the Stanford Linear Accelerator Center since 1979, has made many important contributions to elementary particle theoretical research, and has been the recipient of numerous honors, including the prestigious Dirac Medal in 2000. In addition to her research, she also devotes much of her time to physics education. She was the founding President of the non-profit Contemporary Physics Education Project, and she also manages SLAC's education and outreach programs.

The three others currently in the APS Presidential line, William F. Brinkman, Myriam P. Sarachik, and Marvin L. Cohen, are also members of the National Academy.

Sandia's Z Facility Achieves First Fusion

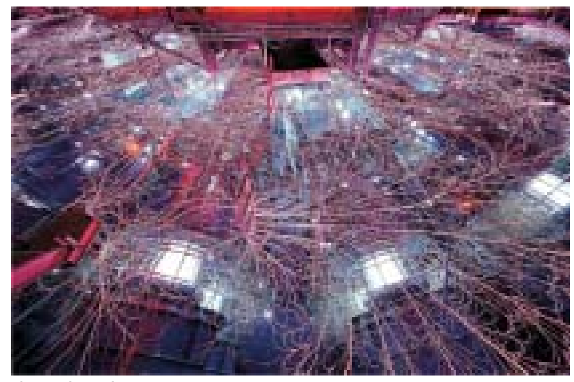


Photo Credit: Randy Montoya

RAW POWER: electrical discharges illuminate the surface of the Z machine, the world's most powerful X-ray source, during a recent accelerator shot.

The first achievement of fusion at Sandia National Laboratory's Z facility in New Mexico was announced at the APS April meeting in Philadelphia.

The Z machine created a hot dense plasma that produces neutrons associated with nuclear fusion. Compressing hot dense plasmas that produce neutrons is an important step towards realizing ignition, the level at which the fusion reaction becomes self-sustaining.

According to Sandia's Ray Leeper, the neutrons emanate from fusion reactions within a BB-sized deuterium capsule placed within the central target in the Z facility, itself about a third of a football field in diameter. While tokamaks cause fusion reactions to occur by confining plasmas in large magnetic fields, and laser facilities focus intense beams on or around a target, Z applies a huge pulse of electricity (about 12 million joules) with very sophisticated timing.

The pulse creates an intense magnetic field which crushes an array of tungsten wires into an ultra-light foam cylinder to produce x-rays. Striking the surface of a fuel capsule embedded in the cylinder, the x-ray energy produces a shock wave that compresses deuterium gas within the capsule, fusing enough deuterium to produce neutrons.

All this action takes place within a container the size of a pencil eraser, called a hohlraum, at the center of the Z machine, itself a circular device about 120 feet in diameter.

Sandia researchers measured a yield of approximately 10 billion neutrons, around the expected energy of 2.45 MeV, corresponding to a very modest level of nuclear fusion (about 4 millijoules of energy). The deuterium capsule reached a temperature of about 11.6 million Kelvin and was compressed from a diameter of 2 mm to 160 microns. The whole compression took about 7 nanoseconds. "Pulsed power electrical systems have always been energy-rich but power-poor," said Leeper. "That is, we can deliver a lot of energy, but it wasn't clear we could concentrate it on a small enough area to create fusion. Now it seems clear we can do that."

Providing outside commentary, Cornell University's David Hammer said that the Sandia group performed a full set of tests to verify that they had achieved nuclear fusion. A partial confirmation of the result came about when theoretical predictions and lab outcomes were determined to be of the same order of magnitude, on the order of 10 billion neutrons. The predicted neutron yield depends on the ion density temperature and volume. Those quantities were independently confirmed by X-ray spectroscopy measurements.

While deuterium-filled capsules driven by lasers have long ago produced neutrons, this experiment represents the first time that the straightforward, relatively inexpensive and potentially robust technology of pulsed power has been able to achieve the conditions of high temperature and density needed to produce measurable thermonuclear neutrons.

The ZR (Z-Refurbished) facility, an upgrade slated to go online in 2006, is expected to scale up fusion experiments. The amount of energy this larger successor could bring to bear offers the eventual possibility of high-yield fusion—the state in which much more energy is released than is needed to provoke the reaction initially to occur. The excess energy could be used for applications such as the generation of electricity. However, while the Z approach to fusion is a promising method, researchers caution that they are at the start of a very long road in terms of investigating its feasibility as a fusion power source.

ZERO GRAVITY *from page 5*

sheep are black!"

The *mathematician* intoned, "In Scotland there exists at least one field, containing at least one sheep, at least one side of which is black."

✶✶✶

What is the difference between and *engineer*, a *physicist*, and a *mathematician*?

An *engineer* believes equations approximate the world.

A *physicist* believes the world approximates equations.

A *mathematician* sees no connection between the two.

✶✶✶

A *farmer*, an *engineer*, and a *physicist* were all asked to build a chicken coop.

The *farmer* says, "Well, last time I had so many chickens and my coop was so and so big and this time I have this many chickens so I'll make it this much bigger."

The *engineer* tackles the problem by surveying, costing materials, reading up on chickens and their needs, writing down a bunch of equations to maximize chicken-to-cost ratio, taking into account the lay of the land and writing a computer program.

The *physicist* looks at the problem and says, "Let's start by assuming spherical chickens....".

✶✶✶

A *physicist*, an *engineer*, and a *statistician* were out game hunting.

The *engineer* spied a bear in the distance, so they got a little closer. "Let me take the first shot!" said the engineer, who missed the bear by three meters to the left.

"You're incompetent! Let me try" insisted the *physicist*, who then proceeded to miss by three meters to the right.

"Ooh, we got him!!" said the *statistician*.

✶✶✶

How they knew it was a deer:

The *physicist* observed that it behaved in a deer-like manner, so it must be a deer.

The *mathematician* asked the physicist what it was, thereby reducing it to a previously solved problem.

The *engineer* was in the woods to hunt deer, therefore it was a deer.

✶✶✶

And finally, we offer our readers "The Metajoke":

An *engineer*, a *physicist* and a *mathematician* find themselves in an anecdote, indeed an anecdote quite similar to many that you have no doubt already heard.

After some observations and rough calculations the *engineer* realizes the situation and starts laughing.

A few minutes later the *physicist* understands too and chuckles to himself happily, as he now has enough experimental evidence to publish a paper.

This leaves the *mathematician* somewhat perplexed, as he had observed right away that he was the subject of an anecdote, and deduced quite rapidly the presence of humor from similar anecdotes, but considers this anecdote to be too trivial a corollary to be significant, let alone funny.

PARTICLES *from page 5*

Model, and speculated that further precision measurements of CP violation might shed light on this question. In addition, she said it might be possible to observe CP violation in neutrinos, which could also help explain the baryon asymmetry of the universe.

Edward Witten, from the Institute for Advanced Study, spoke about the pros and cons of supersymmetry, and although he said he gets out of bed most mornings believing in the SUSY model, he focused primarily on the cons during his talk.

The biggest problem with the SUSY model is that supersymmetric particles haven't been found yet, although he said that wasn't surprising. But SUSY favors a light Higgs and as the bounds on the Higgs mass are pushed up it begins to get uncomfortable. In addition, the supersymmetric extension of the Standard Model reopens some problems that the ordinary Standard Model had solved nicely, such as the natural conservation of baryon and lepton numbers.

Witten remarked, "To me, the central drawback of Super- symmetry is that we don't have a convincing workable picture of what the TeV superworld would really look like," and said that if nature really were supersymmet-ric it would be quite dramatic to see how all these problems managed to get solved.

After the session, attendees were treated to refreshments while they socialized and gazed at the antiquities comprising the museum's internationally renowned collections.

ANNOUNCEMENTS

Call for Nominations for 2004 APS Prizes and Awards

Members are invited to nominate candidates to the respective committees charged with recommending the recipients. A brief description of each prize and award is given in the March 2003 *APS News Prizes and Awards* insert, along with the addresses of the selection committee chairs to whom nominations should be sent. Please visit the Prizes and Awards page on the APS web site at http://www.aps.org under the Prizes and Awards button for complete information regarding rules and eligibility requirements for individual prizes and awards.

PRIZES

Will Allis Prize for the Sudy of Ionized Gases
Hans A. Bethe Prize
Biological Physics Prize
Tom W. Bonner Prize in Nuclear Physics
Oliver E. Buckley Condensed Matter Physics Prize
Davisson-Germer Prize in Atomic or Surface Physics
Dannie Heineman Prize for Mathematical Physics
Polymer Physics Prize
Frank Isakson Prize for Optical Effects in Solids
James C. McGroddy Prize for New Materials
Lars Onsager Prize
W.K.H. Panofsky Prize in Experimental Particle Physics
Earle K. Plyler Prize for Molecular Spectroscopy
Aneesur Rahman Prize for Computational Physics
J. J. Sakurai Prize for Theoretical Particle Physics
Arthur L. Schawlow Prize in Laser Science
Prize to a Faculty Member for Research in an Undergraduate Institution
George E. Valley Jr. Prize
Robert R. Wilson Prize

AWARDS

LeRoy Apker Award ***(June 13, 2003 Deadline)***
Joseph A. Burton Forum Award
Maria Goeppert-Mayer Award
Joseph F. Keithley Award for Advances in Measurement Science
Leo Szilard Lectureship Award

MEDALS AND LECTURESHIPS

David Adler Lectureship Award
Edward A. Bouchet Award
John H. Dillon Medal

DISSERTATION AWARDS

Mitsuyoshi Tanaka Dissertation Award ***(June 30)***
Nicholas Metropolis Award ***(Sept. 15)***
Dissertation Award in Nuclear Physics

NOMINATION DEADLINE IS JULY 1, 2003, UNLESS OTHERWISE INDICATED.

TIME IS ALMOST UP!

APS' half-price promotion for physicists in industry ends on June 30, 2003.

Encourage friends and colleagues to take advantage of this opportunity **NOW**!

Contact the APS Membership Department at 301.209.3280, membership@aps.org, or visit www.aps.org/memb/indoffer.html for details.

CALL FOR NOMINATIONS

George E. Valley Jr Prize

Purpose: To recognize one individual, under age 30, for his or her outstanding scientific contribution to the knowledge of physics. The prize will be presented biennially.

Nature: To recognize one individual, under age 30, for an outstanding scientific contribution to physics that is deemed to have significant potential for a dramatic impact on the field. **The prize will be presented biennially**.

Establishment & Support: The prize was established by the APS Council in 2000 under the terms of a bequest by George E. Valley, Jr.

Rules & Eligibility: The prize shall be awarded to one individual who has reached his/her 30th birthday no earlier than April 1 of the year in which the award decision is made. Nomination documents must include a statement from the nominator or from the candidate's department certifying the birth date of the candidate. Unsuccessful nominations can be carried over to the next time that the prize is awarded provided that: a) the age requirement specified above is still met; b) the nominators update the dossiers of the candidates to include the elapsed two years.

Nomination Deadline: The deadline for submission of nominations for the 2004 prize is: **July 1, 2003**. Five (5) copies of nominations and supporting documentation should be sent to: **Laleña Lancaster,** Attn: George E. Valley Prize, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, lancaste@aps.org

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.

The fundamental constants and their variation: Observational and theoretical status
—Jean-Philippe Uzan
There have been a number of theoretical speculations that the fundamental constants of nature might be changing in time, but there are strong constraints on the possible variation from laboratory experiments aw well as from geophysical and astrophysical observations. This review describes the various observations and evaluates the extracted bounds on the variation. Theoretical motivations for the serarch are also discussed; a clear signal might be evidence for new physics.

Also Recently Posted:

Neutrino masses and mixing: Evidence and implications
—M. C. Gonzalez-Garcia and Yosef Nir

Colloquium: Trapping and manipulating photon states in atomic ensembles
—M. D. Lukin

Quantum dynamics of single trapped ions
—D. Leibfried, R. Blatt, C. Monroe, and D. Wineland

2003 APS Election Opens on June 16

Full information about this year's election, including the list of candidates and their biographies, can be found online at http://www.aps.org/exec/election2003.

Information about the candidates will also appear in next month's issue of APS News. The election closes on September 1.

Physical Review Focus **http://focus.aps.org**

Down-to-earth accounts of hot research from the *Physical Review* journals—ideal for college physics majors and researchers interested in work outside their specialty. Write to **join-focus@lists.apsmsgs.org** to get weekly e-mail updates.

Some Recent *Focus* Stories:

Fermium Wins Heavyweight Title
New measurements make fermium the heaviest and most elusive element to reveal its spectrum.

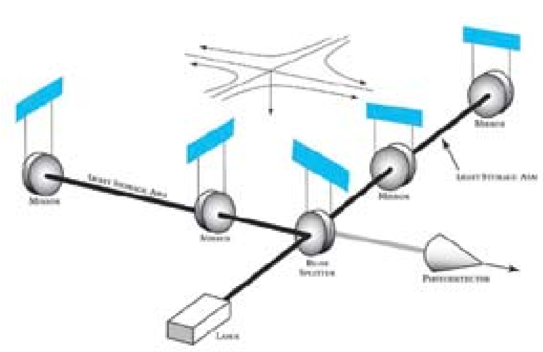
LIGO *from page 1*

ing to astronomers as a tool for peering through clouds of gas and dust to see directly into the core of collapsing stars, deep into the heart of colliding galaxies, and back to the earliest moments of the universe.

They were first predicted by Albert Einstein in 1916 as a consequence of the general theory of relativity, but have yet to be detected directly. In Einstein's theory, alterations in the shape of concentrations of mass (or energy) have the effect of warping spacetime, thereby causing distortions that propagate through the universe at the speed of light.

Predictions about when the first-ever direct detection of gravitational waves will take place depend on how frequently strong bursts of waves bathe the Earth — something scientists do not yet know. LIGO leads a new generation of detectors coming into operation, promising sensitivities capable of detecting a variety of catastrophic events that produce gravitational waves.

With about 440 scientists, LIGO is as large as the many particle physics experiments underway at accelerators. LIGO has two controlling partners—MIT and Caltech —and is located in Washington state and Louisiana, and is also collaborating with other interferometer devices such as Germany's GEO and TAMA in Japan.



Above is a diagram of LIGO Detector. A LIGO staff installing a mode-matching mirror and suspension into a vacuum chamber during the construction of LIGO.

LIGO is essentially a giant strain gauge.

In the LIGO setup, laser light reflects repeatedly in each of two perpendicularly oriented 4-km-long pipes. A passing gravity wave will distort the local spacetime, stretching very slightly one of the paths while shrinking the other, causing the interference pattern of the two merging laser light beams to shift in a characteristic way.

LIGO does not measure static gravitational fields, such as those from the sun or Earth itself. Rather, it strives to see ripples in spacetime radiated by such events as the inspiral of two neutron stars toward each other, a phenomenon which would typically produce a strain in the LIGO apparatus as large as one part in 10^{21}.

That is, a passing gravity wave is expected to change the distance between mirrors some 4 km apart by about 10^{-18} meters, a displacement 1000 times smaller than the size of a proton. Such measurement represents a physics and engineering feat of great delicacy.

In the first run, no gravitational wave events were observed, but palpable knowledge was gained as to what the sky should look like when viewed in the form of gravity waves. So great is LIGO's sensitivity that it has been able to set the best upper limit on the output of gravitational waves from three of the four prime source categories: bursts from sources such as supernovas or gamma bursters; chirps from inspiraling objects such as coalescing binary stars; periodic signals, perhaps from sources like spherically asymmetric pulsars; and a stochastic background source arising from gravity waves originating from the Big Bang itself.

LIGO Deputy Director Gary Sanders of Caltech said that in three of these four categories, the LIGO experiments had set new upper limits on the rate at which gravitational waves were being produced.

In the coalescing binary category, for example, LIGO has established an upper limit of 164 per year from the Milky Way, a factor of 26 better than the previous limit.

Erik Katsavounidis of MIT said that LIGO could establish an upper limit on periodic signals from bright pulsars with a sensitivity of about one part in 10^{-22}.

Realistically, scientists did no expect to detect gravitational waves at LIGO's present sensitivities. But Sheila Rowan (Stanford University and the University of Glasgow) reported that the instrument's second run is currently underway and expected to be ten times more sensitive than the first run. While LIGO's first run was sensitive to gravity waves from the Milky Way, the second, with its tenfold improvement in sensitivity, is expected to expand that range to about 15 million light years, a realm that include the nearby Andromeda galaxy.

Scientists anticipate that the new, improved instrument may detect gravitational waves on a daily basis, with signal strengths capable of revealing details of the waveforms to be read off and compared with theories of neutron stars, black holes, and other highly relativistic objects.

For more information on the LIGO collaboration, see http://www.ligo.caltech.edu.

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at the 2001 March meeting, and included, as well, lectures from the 2001 April meeting and the "Opportunities for Physicists in Biology" meeting that took place in Boston last September.

But this does not mean APS is abandoning the idea. On the contrary, Chodos says, "we hope to enter a new phase in which we can provide web lectures, either from our general meetings or from divisional meetings, to our various units. We hope they will look at the lectures that are up and that they will like what they see. We'll be happy to offer our services if they want to have some of their lectures posted on the web."

The Back Page

The Science of Harry Potter

By Roger Highfield

I love the Harry Potter books. For me every enchantment, spell, curse and other act of sorcery in J.K. Rowling's wonderful creation seems to throw down a challenge to modern science. Surely biologists would be baffled by the phut-like blast of a Skrewt? Surely brain scientists would reject the idea of a hat that can read thoughts? The bizarre creations that populate Harry's world seem at odds with what we know about nature. Surely magic of this sort can't be reconciled with the rational laws of science.

After seeking out the truth as diligently as the long pink tongue of a Puffskein searches for the wizard bogeys, I think it can. Harry's magical world can help illuminate rather than undermine science, casting a fascinating light on some of the most interesting issues that researchers struggle with today. Similarly, what we have learned from our scientific investigations in many fields can help explain many extraordinary and seemingly magical phenomena.

There are some interesting connections between science and magic. They share a belief that what is visible is merely a superficial reality, not the underlying "real reality." They both have origins in a basic urge to make sense of a hostile world so that we may predict or manipulate it to our own ends. Magic, like science, also gives many insights into the workings of the human brain. Both share some decidedly oddball ideas, whether jumping toadstools or quantum jumps.

The technology created by today's wizards and witches makes airplanes fly, computers understand speech, and sends a faltering voice from one side of the planet to another, and is sufficiently inscrutable to most people that these gizmos might as well be the product of sorcery. The biochemistry in a home pregnancy test, the movements of electrons around a silicon chip in a home computer and even the instructions to operate a VCR can count as magic.

A number of episodes in the Harry Potter books suggest that even the magically gifted characters acknowledge that Muggle scientists and technologists do perform a kind of magic. Mr. Arthur Weasley remarks how Muggles use considerable ingenuity to overcome their lack of magic —praise indeed from someone who works for the Ministry of Magic. He is an avid collector of plugs, batteries and anything else to do with "eckeltricity." For Mr. Weasley, even matches offer fun-filled pyrotechnics that rival any wizard display.

For most people, modern science, like magic, requires a leap of faith. In the days of Newton, when almost anyone could conduct practical experiments with prisms and cannonballs, science was more open to amateurs and the laws of nature were more accessible. Today scientific research has become deeply mathematical, and experiments often depend on specialized equipment ranging from billion-dollar atom smashers to gene reading machines. Merely analyzing the results requires thousands more dollars of computer equipment. Most of us have to take the scientists' word for it that these calculations are correct.

While scientists, like wizards and witches, claim to have special knowledge that others don't have, they would be the first to admit that much magic remains in the world. The scientific effort is relatively young, and is still struggling to explain even many everyday phenomena, whether turbulent patterns in a fast-flowing stream, or the language of the brain.

Give this imperfect understanding of the way the world works, imagine what would happen if a Muggle scientist entered Harry's world. Wearing a biohazard suit to protect against Wizard wheezes, bristling with monitoring equipment, and no doubt armed with one of those Muggle metal wands, she takes a good look around Hogwarts. She would probably be struck by how some of what seems magical from Harry's childlike viewpoint seems quite achievable by current Muggle technology. Think of the Chocolate Frog card where Dumbledore suddenly disappears, the mugshot of Gilderoy Lockhart that winked cheerily, or the characters that inhabit Hogwarts paintings.

Now conjure up the map used by Quidditch captain Oliver Wood, marked with arrows that wriggle like caterpillars to show game tactics. A researcher studying electronic displays would recognize that the card, photograph, painting and map could well have been printed on electronic paper, although he might be puzzled by the interface used to update the moving images. How about spoken passwords? A routine task for voice recognition technology.

There are many other phenomena in Harry's world that seem a little less magical to those with a scientific bent. Water-repellant coatings for glass have done away with the need for an Impervius spell. The Howler, a red envelope that contains a screaming missive, doesn't seem too strange in the wake of voice mail or audio files that can be sent over the Internet.

Muggles can now walk through walls, like ghosts, thanks to a technique that creates screens consisting of a smooth sheet of fog onto which the image of bricks and mortar can be projected. The Finnish inventor Ismo Rakkolainen has proposed many potential applications of his fog walls, some of which are indeed magical. Nor does the Marauder's Map, which shows everyone's location in Hogwarts, seem so extraordinary now that GPS technology is so commonplace. Omnioculars seem a bit ordinary when sports fans can overdose on action replays. Why amplify a voice with a cry of "Sonorus" when a public-address system will suffice? And why wear specs, Harry, when you can use a laser beam to carry out corrective surgery?

While such an approach may appear to be the scientific equivalent of the Disillusionment Charm, which strips away magic, many features of Harry Potter's world remain magical when one takes a scientific view. Invisibility cloaks may use clever stealth technology that is only now being developed by Muggles. Broomsticks could function by switching off the tug of gravity, a feat that still seems incredible. Giants, Lobalugs, Hinkypinks and the rest of the magical cast of characters could be the result of genetic modification, a science in its infancy.

But science can actually make the magical world of Harry Potter seem even more extraordinary by laying bare the complexity of creating a double-ended newt, the quantum jumps that color the flash of a wand, or the mind-reading abilities of the Sorting Hat. One can even find the inspiration for basilisks, giants and dragons in the bones of long-extinct creatures.

There are also magical elements in J.K. Rowling's books that are not in themselves scientific, but that chime with scientific understanding. Think of those freshly caught Cornish pixies that ran amok in a Defense Against the Dark Arts class. A thermodynamicist could well see these mischievous electric blue creatures as a manifestation of the second law of themodynamics (loosely interpreted, the law says that chaos rules).

Superstition thrives on uncertainty, and that is bound to remain however many advances science makes. There are even mathematical and scientific reasons to believe that magic and mystery will prevail. Those who are leery of science should take heart from the growing realization in the past century that, in one sense, science rests on an article of faith, as does a belief in the supernatural. The work of Guedel, Turing and Chaitin shows there is something profoundly magical lurking in the logical heart of mathematics, the language of science. There are very real limits to scientific prediction. There are some decidedly odd things lurking in the mathematical foundations of science. And at the ever-expanding horizon of scientific knowledge, new questions, puzzles and mysteries will continue to emerge as surely as existing mysteries are solved.

Like magic, science is just another human endeavor. While the final results of scientific investigation may be cold, logical and impersonal, the process is not. Being human, scientists themselves can be competitive, boastful, sly and deceitful. Science is performed by people who, like any witch or wizard, can be prejudiced, make mistakes, and jump on passing bandwagons. False theories, complacent conservatism and fraudulent claims can thrive within science, as they do in any other human pursuit.

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Science, does, however, at least attempt to account for and do away with subjectivity through experiment, and not just one, but many. Confirmation is crucial. Although many complain that science is too closed to novel ideas, there are countless examples of how, when a stack of evidence mounts against established thinking, those views are abandoned or modified. These examples range from quantum theory, which made Einstein uncomfortable, to the idea of infectious proteins (prions), which were once derided as biological heresy.

One of the characteristic features of magical thought and religious faith that makes them so different from science is that, once the initial premises are accepted, no subsequent discovery will necessarily break the believer's faith, for he can often find a way to explain it away. When a magical spell does not work, it may say more about the person muttering it than the spell itself. Perhaps, like Ron Weasley's attempts at making a feather float, the magical words were not pronounced properly.

Some sociologists and philosophers argue that knowledge is socially conditioned and culturally determined; there is no one single truth about the external world. All beliefs are equally valid, and scientific truth, being one of them, is an illusion. Science does indeed have its own beliefs, such as that the laws of physics are universal and that symmetry plays a profound role in shaping elegant mathematical theories of the universe by helping to simplify calculations. And scientists also believe that the behavior of the universe can be mapped onto mathematics.

Scientists also come up with elaborations to explain away the shortcomings of a dud theory, just as sorcerers conjure up excuses for the shortcomings of a dud spell. But unlike other belief systems, those of science are universal and culture-free because they are endlessly sifted by experiment. Science will eventually abandon any belief or "truth" if the evidence requires it.

Science really is special. It really is the best way of understanding how the world works. Unlike technology or religion, it only originated once in history, in ancient Greece. Even if history were rerun and it took a different course, the conclusions of science would be the same: DNA would still be the genetic material of inheritance, hydrogen would still be the most common element in the universe and star would still be powered by nuclear fusion.

If Newton had not, as Wordsworth put it, voyaged through strange seas of thought alone, someone else would have. If Marie Curie had not lived, we still would have discovered the radioactive elements polonium and radium. But if J.K Rowling had not been born, we would never have known about Harry Potter.

That is why Master Potter means so much to me. Science may be special, but Harry, as a work of art, is more so. Harry Potter is unique.

Roger Highfield is science editor of The Daily Telegraph *in London, England and the author of* The Physics of Christmas. *The above is adapted from his latest book,* The Science of Harry Potter *which appears in paperback in June 2003. Used with permission.*

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.