APS NEWS

A Publication of the American Physical Society

June 2006
Volume 15, No. 6
www.aps.org/apsnews

Highlights

April Meeting Prize and Award Recipients

Photo credit: Howard Pearlman

Front row (l to r): Glen Lambertson, Savas Dimopoulos, Ian Towner, Alysia Marino, Florencia Canelli, Padma Kant Shukla, William Ford, John Heilbron. Middle row (l to r): Nigel Lockyer, Evgenya Smirnova, David Miller, Li-Bang Wang, Sergio Ferrara, Mikhail Shifman, Yuri Orlov. Back row (l to r): Paul Richards, John Hardy, Peter van Nieuwenhuizen, Daniel Freedman, John Jaros, David Albright.

JLab Experiment Discovers Some Strangeness In the Proportion of Strange Quarks

The proton is not as strange as some people might have thought, according to results reported at the APS April meeting. Members of the HAPPEx collaboration at Jefferson Lab described their most recent findings on the contribution of the strange quark to some of the proton's properties.

Protons are composed of two up quarks and a down quark, as well as a sea of virtual quark-anti-quark pairs that flit into and out of existence. It has been an open question how much these sea quarks contribute to properties of the proton, such as its charge distribution and magnetic moment, said HAPPEx collaborator Krishna Kumar of the University of Massachusetts.

A number of experiments have put limits on the strange quark contribution to the nucleon's properties. At the April meeting the HAPPEx collaboration reported that the strange quark contributes at most 4% of the proton's magnetic moment, and at most 1% of its charge distribution. Both of these measurements are consistent with zero. The researchers also found that the strange quark-antiquark pairs in the nucleon are on average separated by less than about $2x10^{-17}$ meters.

The HAPPEx experiment studies scattering of a polarized beam of 3 GeV electrons from liquid hydrogen and from helium, and measures the elastically scattered electrons. The beam's polarization is alternated throughout the experiment. Because the electromagnetic force is mirror symmetric while the weak force is not, the scientist can separate the effects of these two forces by noting differences in the number of scattered electrons when the beam's polarization changes. They then deduce the contribution of the sea quarks to the nucleon's properties.

"The proton is much less strange today than we thought it was two weeks ago," said HAPPEx member Paul Souder of Syracuse University. Tony Thomas, JLab's chief scientist, called the new measurement "the best test of what the sea of the nucleon looks like."

Some previous theories and experiments had hinted that the strange quark could contribute as much as ten percent to the proton's magnetic moment.

Meanwhile, other April Meeting speakers reported on some recently discovered surprising properties of the quark- gluon matter produced at the Relativistic Heavy Ion Collider. Barbara Jacak of SUNY Stony Brook, a member of the PHENIX collaboration at RHIC, described some of these properties during a plenary talk and press conference.

Previous investigation had focused on whether quarks and gluons, normally bound into hadrons, can become free and melt into a so-called quark-gluon plasma, Jacak said. She focused instead on whether the quark-gluon matter produced at RHIC really is a plasma.

The RHIC experiments collide gold ions together at very high energies to recreate a state of matter thought to have existed microseconds after the Big Bang. Four detectors analyze the complicated mess of particles that spew out of the collisions.

At last year's April Meeting, all four RHIC detector groups announced that the soup of quarks and gluons they had produced in these collisions behaved like a nearly perfect fluid of strongly interacting quarks, rather than a gas of weakly interacting quarks.

Now, Jacak and colleagues

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Council Statement Registers Concern Over Potential Nuclear Weapons Use

At its April meeting, the APS Council passed a statement expressing concern over potential use of nuclear weapons by the United States, and calling for a more extensive public debate on this issue. Of particular concern was the danger that any change in US policy would undermine the Non-Proliferation Treaty regime, which seeks to limit the spread of nuclear weapons.

The statement reads:

"The American Physical Society is deeply concerned about the possible use of nuclear weapons against non-nuclear-weapon states and for pre-emptive counter-proliferation purposes.

Nuclear weapons have not been used for more than 60 years, reflecting a widespread appreciation of the grave human costs and political and moral consequences of crossing the nuclear threshold. The American Physical Society urges a prompt, full and informed public debate about the circumstances under which the United States might use or threaten to use nuclear weapons, and the consequences for the Non-Proliferation Treaty."

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Particle Physics at a Crossroads, Academy Study Finds

This is an exciting time in particle physics, and the United States should increase its investment in the field to maintain leadership, says a National Academy of Sciences report released in April.

The report, titled *Revealing the Hidden Nature of Space and Time*, said that the field of particle physics is now at a crossroads, as several major experiments are scheduled to end soon. The report identified several priorities for US particle physics in the next 15 years. The main recommendations, in priority order, are:

–First, support American scientists working at the Large Hadron Collider

–Second, invest in the necessary research and development in order to make a compelling bid to host the International Linear Collider

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CERN Head Says US Should Pay For Part of LHC Operation Cost

CERN Director-General Robert Aymar sparked a mini-maelstrom within the US particle physics community with comments reported in the April 25 issue of the Tribune de Genève. The article quoted Aymar as saying that the LHC has caused CERN to go deeply in debt, and singling out American stinginess as a prime cause.

It turns out that Aymar was misquoted. In a clarifying statement to *APS News*, Aymar said that the Tribune had conflated his comments on two unrelated issues: CERN's current debt, and the US contribution to the LHC. CERN's debt was foreseen when the LHC was approved in 1996, and the institution is on schedule to repay all loans by the end of 2010. However, he is concerned that

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Crowd Packs the Hall for Lisa Randall Public Lecture

Photo credit: James Riordon

High school students, teachers, and other interested members of the public joined physicists at the APS April Meeting in Dallas for "An Evening of String Theory and Cosmology" with Harvard physicist Lisa Randall, author of Warped Passages*. In the photo at left, the crowd listens raptly during the lecture. In the photo at right, after the lecture Randall signs a copy of her book for Gentrea Hendrickson of Hurst, Texas.*

Randall covered the basics of particle physics, string theory, extra dimensions, and the mysteriously elusive hypothetical gravitons, while the students in attendance posed an impressively high caliber of questions during the discussion following the lecture. The evening kicked off with a catered reception at the Dallas Hyatt Regency, where Randall mingled informally with local high school students and their teachers.

Members in the Media

"I try to show people that I am completely normal, that I order the same beer and so forth. But the poor guys–when I start talking about physics, the evening is done."

–Christian Binek, University of Nebraska, Lincoln, the Journal–Star, (Lincoln, Nebraska) April 17, 2006

"There are good reasons to think that the LHC will produce major discoveries."

–Michael Dine, University of California, Santa Cruz, the Santa Cruz Sentinel, April 12, 2006

"It doesn't matter how many collisions you have, you can never change the specific momenta that are in the system. That means you never lose the features you start out with."

–David Weiss, Penn State, on his atomic version of the Newton's cradle toy, which consists of a row of suspended steel balls that knock from side to side, Pittsburgh Post-Gazette, April 13, 2006

"I feel like the mouse that roared."

– Kenneth Ganezer, Cal State-Dominguez Hills, on being named one of the "hottest" researchers by the publication Science Watch, Long Beach Press-Telegram, April 17, 2006

"I get the whole loot. My ego has gotten so big I can barely get through the door."

–Arthur Rosenfeld, UC Berkeley (emeritus), on receiving the Enrico Fermi Award and $375,000 honorarium, San Mateo County Times, April 28, 2006

"It was nice. I got the crown and good cookies."

–Arnold Clark, Lawrence Livermore National Laboratory (retired), on being honored as the oldest member of the Livermore-Amador Symphony, the Tri-Valley Herald, April 28, 2006

"25 percent, if nature's kind."

–Jay Marx, Lawrence Berkeley National Laboratory, on LIGO's chance of seeing gravitational waves, The New York Times, May 2, 2006

"They're not just Shiva the Destroyer; they're Brahma the Creator."

–Scott Hughes, MIT, on black holes, which may influence galaxy development, according to new research, St. Louis Post-Dispatch, April 29, 2006

"The reason for going underground is the same reason why astronomers look at stars at night."

–Ken Lande, University of Pennsylvania, on underground labs, Associated Press, May 5, 2006

"The conventional view is that all of space, time, matter and energy began at a single point ...However, this new theory suggests that there's a continuous cycle of universes, with each a repeat of the last, but not an exact replica. It can be thought of as a child of the previous universe."

–Paul Steinhardt, Princeton University, on his cyclic universe theory, BBC News online, May 5, 2006

"The maple that is used for bats has just about the exact same properties as the ash that is used for bats, which actually somewhat surprised me. They broke about the same, had about the same properties."

–Robert Adair, Yale University, on baseball bats, The Free Lance-Star (Fredricksburg, VA), May 9, 2006

"A plasma cloud is going to be by nature composed of electrons and ions. When they recombine to form atoms they're going to release light and therefore they will glow."

–Iver Cairns, University of Sydney, on plasma clouds, which may provide a plausible explanation for some UFO sightings, Australian Broadcasting Corporation, Science Online, Australia, May 8, 2006

"And we can go back in this machine to like a trillionth of a second after the Big Bang, recreate the conditions that existed then … but we cannot go to the ultimate cause."

–-Roger Dixon, Fermilab, CBS News, Chicago, May 7, 2006

"Neutrinos just keep going. They go under Wisconsin, a little bit east of Madison, under Lake Superior, and into Minnesota."

–Marvin Marshak, University of Minnesota, describing the MINOS experiment, NPR, All Things Considered, May 3, 2006

"Physics explains chemistry, chemistry explains biology. There's a coherence, and that's what science is all about."

–Leon Lederman, Fermilab, on why physics should be taught before chemistry and biology in high schools, Baltimore Sun, May 9, 2006

This Month in Physics History

June, ca. 240 B.C. Eratosthenes Measures the Earth

Eratosthenes

By around 500 B.C., most ancient Greeks believed that Earth was round, not flat. But they had no idea how big the planet is until about 240 B.C., when Eratosthenes devised a clever method of estimating its circumference.

It was around 500 B.C. that Pythagoras first proposed a spherical Earth, mainly on aesthetic grounds rather than on any physical evidence. Like many Greeks, he believed the sphere was the most perfect shape. Possibly the first to propose a spherical Earth based on actual physical evidence was Aristotle (384-322 B.C.), who listed several arguments for a spherical Earth: ships disappear hull first when they sail over the horizon, Earth casts a round shadow on the moon during a lunar eclipse, and different constellations are visible at different latitudes.

Around this time Greek philosophers had begun to believe the world could be explained by natural processes rather than invoking the gods, and early astronomers began making physical measurements, in part to better predict the seasons. The first person to determine the size of Earth was Eratosthenes of Cyrene, who produced a surprisingly good measurement using a simple scheme that combined geometrical calculations with physical observations.

Eratosthenes was born around 276 B.C., which is now Shahhat, Libya. He studied in Athens at the Lyceum. Around 240 B.C., King Ptolemy III of Alexandria appointed him chief librarian of the library of Alexandria.

Known as one of the foremost scholars of the time, Eratosthenes produced impressive works in astronomy, mathematics, geography, philosophy, and poetry. His contemporaries gave him the nickname "Beta" because he was very good, though not quite first-rate, in all these areas of scholarship. Eratosthenes was especially proud of his solution to the problem of doubling a cube, and is now well known for developing the sieve of Eratosthenes, a method of finding prime numbers.

Eratosthenes' most famous accomplishment is his measurement of the circumference of Earth. He recorded the details of this measurement in a manuscript that is now lost, but his technique has been described by other Greek historians and writers.

Eratosthenes was fascinated with geography and planned to make a map of the entire world. He realized he needed to know the size of Earth. Obviously, one couldn't walk all the way around to figure it out.

Eratosthenes had heard from travelers about a well in Syene (now Aswan, Egypt) with an interesting property: at noon on the summer solstice, which occurs about June 21 every year, the sun illuminated the entire bottom of this well, without casting any shadows, indicating that the sun was directly overhead. Eratosthenes then measured the angle of a shadow cast by a stick at noon on the summer solstice in Alexandria, and found it made an angle of about 7.2 degrees, or about 1/50 of a complete circle.

He realized that if he knew the distance from Alexandria to Syene, he could easily calculate the circumference of Earth. But in those days it was extremely difficult to determine distance with any accuracy. Some distances between cities were measured by the time it took a camel caravan to travel from one city to the other. But camels have a tendency to wander and to walk at varying speeds. So Eratosthenes hired bematists, professional surveyors trained to walk with equal length steps. They found that Syene lies about 5000 stadia from Alexandria.

Eratosthenes then used this to calculate the circumference of the Earth to be about 250,000 stadia. Modern scholars disagree about the length of the stadium used by Eratosthenes. Values between 500 and about 600 feet have been suggested, putting Eratosthenes' calculated circumference between about 24,000 miles and about 29,000 miles. The Earth is now known to measure about 24,900 miles around the equator, slightly less around the poles.

Eratosthenes had made the assumption that the sun was so far away that its rays were essentially parallel, that Alexandria is due north of Syene, and that Syene is exactly on the tropic of cancer. While not exactly correct, these assumptions are good enough to make a quite accurate measurement using Eratosthenes' method. His basic method is sound, and is even used by schoolchildren around the world today.

Other Greek scholars repeated the feat of measuring the Earth using a procedure similar to Eratosthenes' method. Several decades after Eratosthenes measurement, Posidonius used the star Canopus as his light source and the cities of Rhodes and Alexandria as his baseline. But because he had an incorrect value for the distance between Rhodes and Alexandria, he came up with a value for Earth's circumference of about 18,000 miles, nearly 7,000 miles too small.

Ptolemy included this smaller value in his treatise on geography in the second century A.D. Later explorers, including Christopher Columbus, believed Ptolemy's value and became convinced that Earth was small enough to sail around. If Columbus had instead known Eratosthenes larger, and more accurate, value, perhaps he might never have set sail.

APS NEWS

Series II, Vol. 15, No.6
June 2006

Coden: ANWSEN ISSN: 1058-8132

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APS News (ISSN: 1058-8132) is published 11X yearly, monthly, except the August/September issue, by the American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, (301) 209-3200. It contains news of the Society and of its Divisions, Topical Groups, Sections and Forums; advance information on meetings of the Society; and reports to the Society by its committees and task forces, as well as opinions.

Letters to the editor are welcomed from the membership. Letters must be signed and should include an address and daytime telephone number. The APS reserves the right to select and to edit for length or clarity. All correspondence regarding APS News should be directed to: Editor, APS News, One Physics Ellipse, College Park, MD 20740-3844, E-mail: letters@aps.org.

Subscriptions: APS News is an on-membership publication delivered by Periodical Mail. Members residing abroad may receive airfreight delivery for a fee of $15. Nonmembers: Subscription rates are available at http://librarians.aps.org/institutional.html.

Subscription orders, renewals and address changes should be addressed as follows: For APS Members–Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org.

For Nonmembers–Circulation and Fulfillment Division, American Institute of Physics, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502. Allow at least 6 weeks advance notice. For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing issues will be honored without charge only if received within 6 months of the issue's actual date of publication. Periodical Postage Paid at College Park, MD and at additional mailing offices. Postmaster: Send address changes to APS News, Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Happy Birthday, AIP!

Photo credit: Ernie Tretkoff

On May 3, the American Institute of Physics celebrated 75 years of service to the physics community with an all-day symposium at the Cosmos Club in Washington. The AIP was founded on May 3, 1931 at the Cosmos Club (then at a different Washington location) by the APS, the Optical Society of America, the Acoustical Society of America, and the Society of Rheology. It now has ten member societies. Among the speakers at the symposium, entitled "Diverse Frontiers of Science", were AIP CEO Marc Brodsky, Astronomer Royal Lord Martin Rees of Cambridge University, Nobel Laureate Steven Chu of Lawrence Berkeley Laboratory, and APS Past President Marvin Cohen of the University of California, Berkeley. In addition, President Bush's science advisor John Marburger gave a featured address, and National Academy of Sciences President Ralph Cicerone gave the banquet speech.

In the photo, Jack Hehn and Margaret Wiley of AIP admire one of several special plaques created for the occasion.

Bringing the Universe Down to Earth

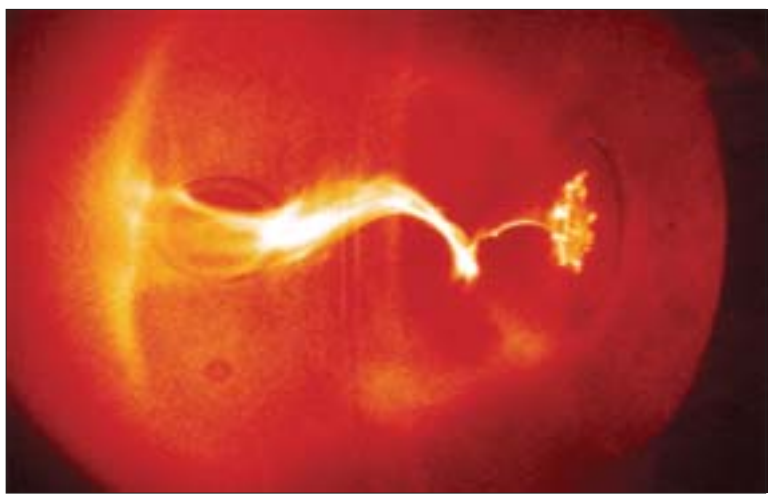

Photo credit: http://ve4xm.caltech.edu/Bellan_plasma_page/

A "kinky" plasma jet.

Scientists are increasingly turning to laboratory-based experiments to gain insight into the mechanisms that affect plasmas in space. Speakers at a handful of sessions at the APS April meeting in Dallas described some of their recent work in this area, shedding light on such questions as solar flares, the temperature of the sun's corona, astrophysical jets, and the interiors of neutron stars.

Many of the complex phenomena seen in space are difficult to understand with existing theories. This is partly due to the fact that much of the universe is made of plasmas, which exhibit highly complex behavior. Thus, it can be difficult to come up with good mathematical models. Physicists can predict the behavior of individual fluid particles, but plasmas are comprised of very large numbers of particles that are constantly in motion. They are also charged particles, so their motion is affected by electric and magnetic fields, especially the magnetic fields of nearby stars and galaxies.

Plasma-related phenomena can be seen in the sun's periodic solar flares, which eject powerful bursts of charged particles so strong they can sometimes interfere with earth-bound communications. Michael Brown, a physicist at Swarthmore College, has created scaled-down experimental versions of solar phenomena in the laboratory, building arrays of wire loops to study magnetic reconnection in plasmas. Magnetic fields are forced together, like two strands of a rope, and annihilate each other, producing a burst of excess energy. This accelerates the plasma outward to produce a solar flare.

Brown's laboratory plasmas are about one foot tall whereas those on the sun are about five times the diameter of Earth, but the temperature of the gas and the strength of the magnetic field are about the same in both cases. Among other things, such studies may help solve the mystery of why the temperature of the sun's corona is so much hotter than the core.

The jet plumes of plasma emitted by certain galaxies are the focus of the laboratory simulations produced by Caltech's Paul Bellan. As matter falls inward toward a star or black hole, forming an accretion disk, the jets shoot out along the axis of the disk.

Even small jets are roughly the size of our solar system. Bellan's

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INSIDE THE BELTWAY: WASHINGTON ANALYSIS AND OPINION

Pain and Politics at the Pump

By Michael S. Lubell, APS Director of Public Affairs

According to gasbuddy.com, the cheapest price for a gallon of regular in the DC area is $2.82 at a Sunoco Station in Woodbridge, Virginia. Inside the District, gasbuddy says it will cost you $3.29 at the Exxon Station on 22nd and P. I find the 47-cent spread pretty remarkable.

But I find it even more amazing that there is a website dedicated to providing such information. Hold on, you say, there's a website for everything these days. True, but if you google "gas price," you find ten sites on the first page alone. Although they don't tell you how many hits they get each day, they must be getting enough to make money from their advertising.

Consumers are clearly feeling the pain as they drive around in their gas-guzzling SUV's and Hummers, wondering what hit them. And when consumers cry, "Ouch!" politicians don't think clearly. Invariably they try for a quick fix.

So what have our elected representatives proposed? Republicans floated the idea of putting a $100 check on every driver's seat. That elicited such hoots of political pandering from consumers that the leadership quickly buried the idea.

Democrats called for investigations of price gouging, a windfall profits tax and suspending the 18.5 cent per gallon highway tax. The public hasn't bought that line either. Besides, despite holding 202 seats in the 435-member House, Democrats in that chamber have little clout, check that, no clout.

Congress and the White House have dithered over meaningful energy policy for years, and the public, feeling the pinch at the pump and fed up with the Iraq war, is now expressing out-

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CERN CONTINUED FROM PAGE 1

"the Member States have mortgaged the organization's future," since CERN will have "limited flexibility to invest in long-term R&D."

Aymar does strongly believe that the US should contribute not just to the construction of the facility and its detectors, but also help offset its operating costs. "I would like to see all participating countries contribute to running costs in proportion to the benefit they stand to gain from the LHC," Aymar said."As things stand today, some 751 of CERN's 6775 users are Americans, while the US will contribute nothing to the running of the LHC machine."

Aymar argues that while traditionally in particle physics, each region has borne the full operating costs of its own facilities, times have changed. The movements of researchers from one region to another no longer evens out.

"The LHC is a unique facility, and will be a focus for the global particle physics community for many years to come," Aymar told *APS News*. "It is reasonable, therefore, that the running costs be shared equitably between participants. I believe that we have to take this into account in financing both the construction and the operation of such facilities."

Melvyn Shochet of the University of Chicago concurs with Aymar's historical remarks, pointing out that Fermilab's Tevatron collider-the energy frontier machine for several decades-has hosted many scientists from Europe and Asia. Those countries contributed to the construction of the detectors and their operation, while the US bore the accelerator operating costs. The US contribution to the accelerator construction costs at the LHC is actually unprecedented, according to Shochet, and the current agreement calls for accelerator operating expenses to be born by the host (CERN), per the long-standing tradition.

Shochet is the current Chair of the High-Energy Physics Advisory Panel (HEPAP), which supplies guidance on high-energy physics to both DOE and NSF.

Aymar's comments in the Tribune de Genève preceded by one day the release of a report from the National Academy of Sciences, *Revealing the Hidden Nature of Space and Time: Charting the Course for Elementary Particle Physics* (see story, page 1). That report concluded that "the highest priority for the US national effort in elementary particle physics should be to continue to be an active partner in realizing the physics potential of the LHC experimental program". The report states that "US research groups that will carry out research at the LHC need to be adequately supported, and the US should participate in upgrades of experimental facilities", but does not call for US support of LHC operating costs.

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–Third, expand the program in particle astrophysics and pursue an internationally coordinated program in neutrino physics.

Harold Shapiro, an economist and former President of Princeton University, chaired the NRC's Committee on Elementary Particle Physics in the 21st Century which drafted the report. He announced the panel's recommendations at a press conference April 26 in Washington.

Several major particle physics experiments will come to an end soon, the committee noted. Fermilab is scheduled to shut down around 2010. Shapiro said he had been disappointed to learn that no plan was in place for the future. "When we looked at the status of high-energy physics in the US, we were sobered," he said. "We had no compelling follow-on program."

The report says that the United States should play a leadership role in the worldwide effort to study Terascale physics, and accelerators are an essential component of this effort.

The panel recommends spending $300 to $500 million over the next five years on research and development for the accelerator for the proposed International Linear Collider. The panel also recommends that the US expresses its strong intent that the ILC will be built in the United States.

Shapiro noted that this is a risky strategy, but said that doing nothing would be even riskier. If nothing is done, US particle physicists will be forced to work abroad, and students will lose interest in the field, he said.

Experiments at the Terascale may soon enable physicists to answer some exciting questions, such as where particle masses come from, whether the forces of nature are unified at some energy scale, whether space and time have extra dimensions, and what makes up the dark matter. The LHC, scheduled to begin operation in 2007, could discover the Higgs boson, evidence of supersymmetric particles, or evidence of new physics. The ILC, which will collide electrons and positrons, will be able to clarify and provide more details about any discoveries made by the LHC.

"This might be the most exciting moment in particle physics in a generation" said Shapiro.

In the short run, the panel found, funds could be reallocated from experiments that are ending in the next few years. But an increase in resources will be needed to sustain US leadership in particle physics. The panel says the budget for particle physics needs to increase by at least 2% to 3% per year in real terms.

The committee also discussed how to avoid the kind of problems that led to the cancellation of the SSC by Congress in 1993. Shapiro said that the committee believes the ILC is on a better path because it will be an international collaboration from the very beginning.

The 22-member committee included particle physicists, physicists in other fields, and non-physicists.

This unusual composition of the committee meant that the physicists had to work harder to make the case for why particle physics is important.

Committee member Jonathan Bagger of Johns Hopkins University said that it was clear that American particle physics is at a crossroads, and it was important to have people outside of physics look at the field.

The report is part of the Physics 2010 project, a series of National Research Council studies that will explore opportunities and priorities for many branches of physics.

Letters

Religion is Not the Same as Superstition

Both as a religious person and as a scientist, I find myself wholeheartedly agreeing with Lawrence Krauss's position in the April Back Page on so-called Intelligent Design. What I find grossly unacceptable is the gratuitous attack on "religion". The issue is not religion, but superstition. There is a difference between the two.

To the overwhelming majority of modern religious Jews, together with thoughtful people in other religions, it is clear that a sort of complementarity principle holds for religion, that religious belief cannot incorporate aspects that are in contradiction to scientific knowledge. As a simple example, a Jewish tradition forbids one to pray for something to not have occurred after the fact, because a request for divine intervention to undo a

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Scientists' Arrogance Makes Matters Worse

It seems to me that Lawrence Krauss (*APS News* Back Page, April 2006) wishes to add to the controversy which he denies exists. The public perception that there is a controversy is documented by the statistics he quotes. The arrogance of scientists, illustrated so well by this essay, fuels the "controversy" and adds to the public distrust of science and scientists. Is it to much to ask that scientists admit that there are things unknown to science, that there are limits to the scope and depth of science, and that evolutionary theory is incomplete in its detail, particularly with respect to the descent of Man. One problemn is the time scale of the evolutionary process. It is simply impossible to repeat the process of the evolution of the universe, including that of earth, and its inhabitants. The archeological record is incomplete and the gaps must be filled with reasonable speculation. If the goal is to educate the public, the public must be treated as a partner in the education process, not as backward bumpkins.

The public (mis)understanding of science is due, in large part, to the manner in which science is presented by our system of education. Try to do something about that, but don't claim infallibility; that claim is usually made by clerics.

Lighten up, Mr. Krauss. We are all truth seekers! And we are not about to blow up the Supreme Court Building.

Fletcher Gabbard
McKee, KY

Origin of Life Still Controversial

Several times in his April Back Page article, Lawrence Krauss states that there is no controversy in the Darwinian theory of evolution. How can anyone claim that there is no controversy when the theory of how life originated on Earth, the very first step in the process of evolution of the species, is unresolved, with no convergence in sight among the diverse theories. The Oparin-Haldane hypothesis, tested by the Miller-Urey experiments, is now in disfavor, because there is no evidence that 3.86 billion yrs ago (when over 30 life forms emerged rather

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Occam's Razor Cuts Out Intelligent Design

Advocates of creationism and intelligent design accuse science of assuming methodological naturalism (the view that natural effects must have natural causes) a priori, thereby unfairly excluding their own ideas without a hearing. Lawrence M. Krauss (The Back Page, April 2006), rather than debunk this accusation, concedes their point by equating methodological naturalism with the scientific method.

However, the scientific method does not limit the kinds of causes that it can invoke when arriving at a theory. To choose among alternative theories that explain the same observations, science applies Occam's razor and adopts the most parsimonious. This "metaphysically neutral" criterion is one that creationism and intelligent design fail to meet.

So a theory is not scientific because it is based on "natural" concepts like matter and energy. On the contrary, such concepts have come to be regarded as "natural" because they are endorsed by science.

John G. Fletcher
Livermore, CA

Science is Trying to Silence Religion

The April Back Page headline, "When Worldviews Collide: Science and Religion Face Off Again", implies the face-off is between science and religion. The face-off is really between the secular and the religious citizens of our society.

I am a Christian, a Protestant with Calvinist roots (the worst kind), and have always believed that God reveals himself through his works in nature and in special revelation, for me the Bible. Since these revelations must be compatible, I have never had a problem with applying the scientific method to evolution or any other matter of science.

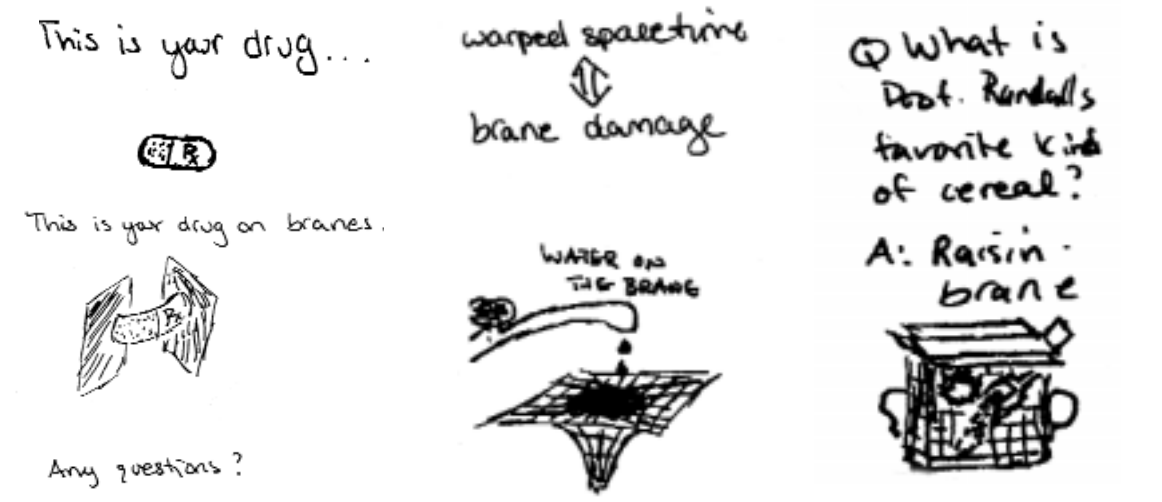
What really is going on in our society is that citizens with a secular bias are trying to silence citizens with a religious bias, even though our Constitution guarantees free exercise of religion for the religious and, I suppose, freedom from exercising religion for the secular.

The article in question admits, "science is not inherently atheistic. The existence of God isn't a scientifically testable proposition." If this is correct, God may or may not exist, and Evolution and Intelligent Design as a result are on an equal footing as far as science is concerned.

George A. Kuipers
Pittsford, NY

zero gravity
The Lighter Side of Science

At the public lecture in Dallas by Lisa Randall (*see story on page 1*) survey cards were distributed to find out who the members of audience were and how they heard of the event. The attendees were about a third physicists from the meeting, a third students, and a third other members of the public. The students had mainly heard about the lecture from their teachers (APS Outreach, working with event host Victoria Smith Downing of the Kilby Foundation, had canvassed many local schools), and the public through flyers and other means including the radio. One of the cards, however, was returned with a series of drawings on the back making visual fun of the word "brane." Although the author had not signed his name, the APS crack forensic team determined that it was the work of Todd Tinsley of Rice University, who, when his identity was revealed, graciously allowed us to reproduce some of it for the enjoyment of readers of *APS News*.



Evolution is not Dogma

In his April Back Page article, Lawrence Krauss says, "People who oppose evolution are really trying to take a stand against science and rationality." It's difficult for me to believe that he really means this. I know many people who do not believe in evolution. All are perfectly sane, many impress me with the depth of their understanding of life, and some are scientists (in various fields) who have a respectable list of

Evolution continued on page 7

Intelligence Fellowships Go Back to 1979

I was pleased to learn from the article "APS Member Honored for Intelligence" in the April *APS News* that Dwight Williams of Defense Intelligence Agency's MASINT organization received a DNI Fellowship for 2006, and applaud *APS News* for recognizing the honor. However, I would like to point out that although these Fellowships have just been designated "DNI Fellowships," there have existed "DCI Fellowships" since 1979. "DCI " designates the Director of Central Intelligence, who was both the Director of CIA and the overseer of all 15 Intelligence Agencies prior to Congress creating the DNI position in 2004. Many scientists (some APS members) have benefitted from these fellowships over the 27 years of the program. Both myself and Dr. L. Dudley Miller (no relation) of the Army's National Ground Intelligence Center were DCI Fellows in the 1983 - 1985 fellowship period. Based largely on knowledge and experience gained

Intelligence continued on page 6

Quark-Gluon Liquid Report Contains Flaws

The piece "An Ocean of Quarks" in "Physics News in 2005", included in the February, 2006 *APS News* contains some small errors.

In central collisions at RHIC, the total collision energy is at most 36 TeV, rather than the 40 TeV given in the article.

In addition, the references given are a poor match to the content of the item. The 4 experimental "white papers" were largely written in 2004 and do not claim the observation of a quark-gluon liquid. That claim is newer, most notably from the talks, press conference and press release at the April, 2005 APS meeting.

Spencer Klein
Berkeley, CA

Show Us the Evidence

James Hansen's Viewpoint column in the April 2006 *APS News* had a nice, but misleading and quite inadequate, graph of annual mean global temperature change showing measured temperature changes from about 1960 to present and projections to 2020. If he would really like to destroy Michael Crichton's objections to the projections for global warming, he should display a graph showing calculations that incorporate the known atmospheric concentrations of carbon dioxide since about 1800. Assuming that the period from, say, 1800 to 1900 could be used to establish the fine tuning needed to duplicate mean temperatures for that period, then the model should be able to predict what has happened since 1900. A duplication of known histories is always a firm requirement for the oil and gas reservoir simulations that I have done. The economic stakes are so very much larger for simulations of our climate system that it will be difficult to obtain the level of cooperation needed for greenhouse gas control without compelling evidence that the climate models are right. If we have the evidence, let's show it!

Stan Robertson
Weatherford, OK

George Valley Worthy of Commemoration

I was delighted to see the article on the George Valley Prize and the rather brief note of his contributions to the Radiation Laboratory. He was a "systems man" being essential to a number of important projects, particularly in the translation from the laboratory groups Receiver Components and Precision Circuits. He was a particular leader in the first radar bomb sight that alleviated Hap Arnold's inexperience of bombing through overcast; it provided a relatively accurate bombsight to the 8th Air Force Pathfinder planes, which previously could only drop

George Valley continued on page 7

Can DNA Code Rewrite Itself?

In his book *Darwin's Black Box*, M. J. Behe describes frustration with trying to get the requirement that evolutionary molecular processes be randomly generated in infinitesimal degrees to agree with experimental observations. Those observations suggest that the evolutionary processes observed when unicellular organisms mutate occur too rapidly to be random and that the changes appear to be in groups of simultaneous changes.

I was impressed with the similarity of the behavior of the immune system with the kind of computer code that generates "popups" on an internet web site. If simple binary code run on a simple silicon-based CPU can rewrite itself under the influence of someone's mouse clicks, why couldn't the more

DNA Code continued on page 6

Unexpected Bonus

My partner and I both enjoyed playing "Find the Physicists" in the April issue of *APS News*. But it turns out the story has an unexpected extra: Bethe appears twice, not once: "Lomb BET HE could..." and "could BE THE judge..."–kudos to the authors for this pleasant way to pass an hour (or so)!

John Bechhoefer
Burnaby, British Columbia

"Starquakes" Reveal Clues About Magnetar Composition

At the APS April Meeting in Dallas, Tod Strohmayer of NASA's Goddard Space Flight Center demonstrated how the detailed trace of x-rays arriving from magnetars can be converted into information about seismic modes shaking the star and how properties of the star's crust can be deduced from that. Among other findings, Strohmayer and his colleagues have measured the thickness of the crust of a neutron star for the first time.

When massive stars explode at the end of their lives, they can leave behind very dense, spinning neutron stars. Very little is known about their structure, but astronomers believe their cores may contain a state of matter that doesn't exist anywhere else in the cosmos, at least not since the Big Bang itself. Magnetars are a specific type of neutron star featuring colossal magnetic fields, as high as 10^{15} Gauss. These fields might be strong enough to crack the crusts of the stars, and this in turn could prove to be the source of the huge energy bursts–dubbed hyperflares–coming to Earth from these dynamic objects.

One such event in 1998 and another in December 2004 are believed to have dispatched the largest batch of radiation to be detected from outside the solar system. The NASA team used the Rossi X-Ray Timing Explorer to make the measurements of a neutron star named SGR 1806-20, located about 40,000 light years from Earth in the constellation Sagittarius. Vibrations from the explosion revealed details about the star's composition, much like how the study of seismic waves on Earth can reveal the structure of our planet's crust and interior.

"We think this explosion, the biggest of its kind ever observed, really jolted the star and literally started it ringing like a bell," he said. "The vibrations created in the explosion, although faint, provide very specific clues about what these bizarre objects are made of. Just like a bell, a neutron star's ring depends on how waves pass through layers of differing density, either slushy or solid."

Among other data, Strohmayer presented fresh analysis of the 1998 and 2004 events, including the identification of additional vibrational modes. The measurements were confirmed using the Ramaty High Energy Spectroscopic Solar Imager, which also recorded the hyperflare and provided evidence for a high-frequency oscillation at 625 Hz, indicating waves traversing the crust vertically. The abundance of data enabled the researchers to determine the depth of the neutron star's crust–nearly a mile, assuming a diameter of 12 miles across–by comparing the frequencies from waves traveling around the crust to those traveling radially through it.

According to Strohmayer, starquake seismology is a promising method for determining the properties of neutron stars, and a larger explosion detected in X-rays could reveal the elusive secret of the nature of the matter at such a star's core. That material may be so dense that a single teaspoon would weigh close to 10 million tons on Earth. Among other exciting possibilities, the core might contain free quarks, which could further advance our scientific understanding of the nature of matter and energy.

"Neutron stars are great laboratories for the study of extreme physics," said Anna Watts, Strohmayer's colleague, who is now at the Max Planck Institute for Astrophysics in Garching, Germany. "We'd love to be able to crack one open, but since that's probably not going to happen, observing the effects of a magnetar hyperflare on a neutron star is perhaps the next best thing."

Lorentz Invariance Still Stands

Lorentz invariance expresses the proposition that the laws of physics are the same for different observers, for example, an observer at rest on Earth or one who is rotated through some angle, or traveling at a constant speed relative to the observer at rest. It is the pillar of Einstein's theory of special relativity, and every experiment conducted to date has verified it. But if new, far more sensitive experiments could detect a very faint field pervading the cosmos, one that exerts a force on electron spin, that would topple Lorentz invariance.

Fortunately for fans of Einstein and relativity, a new experiment at the University of Washington sought just such an anomalous field and came up empty-handed, even at an unprecedented energy scale of 10^{-21}, according to results presented at the APS April Meeting in Dallas. This is the most stringent search to date (by a factor of 100) for violations of Lorentz invariance involving electrons.

Eric Adelberger's UW group is conducting an ongoing battery of tests carried out with a flexible and sophisticated torsion-balance apparatus. In 2000, they were one of three separate research groups to measure the gravitational constant ("Big G") to the greatest precision to date, although the various measurements didn't agree with each other.

Most recently, they set out to test Lorentz invariance with a torsion pendulum, in hopes that even a slight departure from expected behavior in spacetime might signal an interesting new phase in our understanding of the universe. According to Clare Cramer, a member of Adelberger's research group, in this particular experiment, the apparatus involved a pendulum made of blocks whose magnetism arises from both the orbital motion of an electron around its nucleus and from the intrinsic spin of the electron itself.

By carefully choosing and arranging the blocks, they can create an assembly that has zero magnetization and yet still has an overall nonzero electron spin. Cramer calls this condition a "spin dipole," and likens it to the case of an electric dipole, which has zero net charge, yet possesses a net electric field because of a displaced arrangement of positive and negative charge. The existence of a preferred-direction, Lorentz-violating, spin-related force would have shown up as a subtle mode in the rotation of the pendulum. The conclusion: any such "quasi-magnetic" field would have to be weaker than about a femto-gauss.

They are also searching for evidence of extra dimensions in the form of departures from Newtonian gravity–such as the inverse-square dependence–at size scales of tens of microns. While the group did find some strange results at a measurement scale of about 70 microns, Adelberger conceded this was most likely due to an experimental artifact.

A portion of the above article appeared in Physics News Update Number 775.

High School Teachers' Day in Dallas

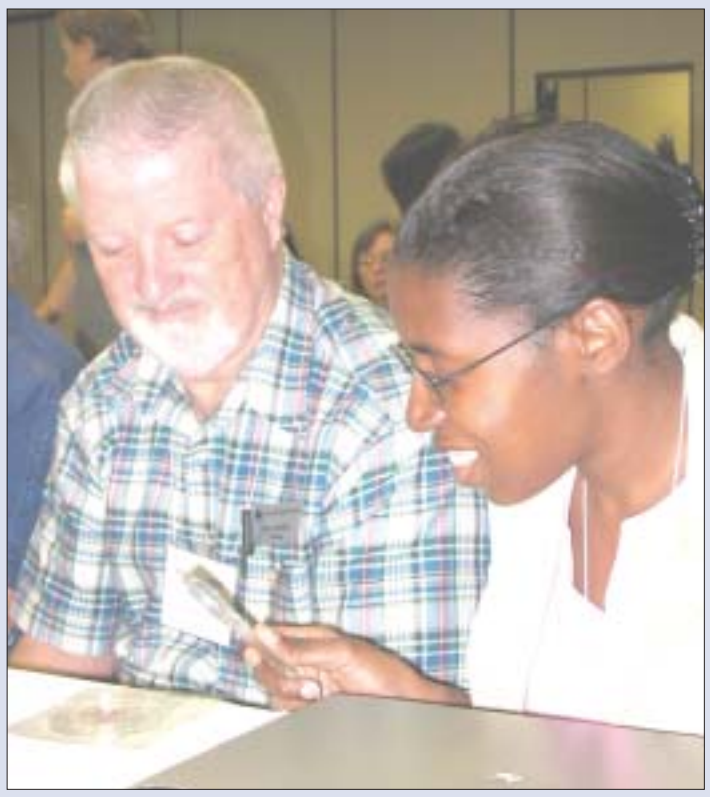


Photo credit: Ed Lee

At an APS High School Physics Teachers' Day workshop in Dallas, William Griffith and Kendra Bonnet explored fractal patterns in a crystal that they had just grown. The workshop was led by Richard Olenick of the University of Dallas.

Physics Helps Bolster Homeland Security

Many physicists are applying basic physics in unexpected ways to homeland security problems, and several groups reported their progress at the April Meeting.

For instance, a group of researchers from Sandia National Laboratory and Lawrence Livermore National Laboratory has proposed building small neutrino detectors for monitoring nuclear reactors.

Nuclear reactors that produce electric power must be monitored to make sure that fissile materials are not diverted for weapons purposes. Currently, the International Atomic Energy Agency monitors nuclear reactors with regular detailed inspections, which are time-consuming and costly.

Now, Nathaniel Bowden of Sandia National Laboratory and his colleagues have proposed a new method for real-time monitoring of nuclear reactors. A smaller version of the same type of detector that scientists use to study solar or atmospheric neutrinos could detect the antineutrinos produced by nuclear power reactors and give a measure of the amount of plutonium in the reactor core, Bowden and colleagues suggest.

Neutrinos interact infrequently and are hard to detect, Bowden points out, but they are also impossible to shield, so it would be impossible to hide the antineutrinos produced in a nuclear reactor.

Bowden and colleagues have already built a prototype detector, which they have installed about 25 meters from the San Onofre nuclear generating station in San Clemente, Calif. The prototype detector is about 3 m by 3 m by 3 m, and the researchers believe it could be made even smaller.

About 10^{26} antineutrinos are emitted by the reactor each day, and several thousand interact with a proton in the detector.

With the prototype, the researchers can clearly see the reactor turning on and off, and they have preliminary indications of sensitivity to production of plutonium.

If the IAEA could adopt this system, it would allow real-time monitoring of plutonium production that could greatly reduce the need for inspections, Bowden says. He and colleagues plan to carry out a cost-benefit analysis to determine whether this method of monitoring reactors would be practical.

In another example of basic science being applied to security problems, seismologist Paul Richards of Columbia University discussed using earthquake detectors to sense nuclear explosions.

To a non-specialist, an earthquake looks very similar to a nuclear explosion, but scientists can tell them apart because of the different patterns of shear and compression waves. Even if a country attempts to evade detection, tests above 1 or 2 kilotons cannot be confidently hidden, said Richards. There is already a large seismic monitoring infrastructure already in place that can detect explosions from a distance, and seismologists can distinguish a nuclear explosion from the 200 earthquakes that occur every day. In fact, seismology has turned out to be the most important way of monitoring nuclear explosions, said Richards.

However, locating an explosion precisely enough is still challenging. Richards and others are working on techniques for solving that problem. In addition to improving the monitoring of nuclear testing, the research is also leading to improvements in seismologists' ability to precisely locate earthquakes, he said. Richards received the Szilard Award for his work in this area.

Edward Hartouni of Lawrence Livermore National Laboratory talked about how scientists are working the problem of monitoring cargo entering the country to keep out illicit nuclear material. Millions of cargo containers enter the country each year, and at some ports as many as ten containers per minute must be processed. Opening and searching each one would be impossible. Radiation detectors would detect non-threatening radioactive materials, such as fiestaware. All solutions proposed so far have problems, but physicists are continuing to work on better methods of monitoring cargo, said Hartouni.

These are all examples of how scientists working on basic research can apply their knowledge to problems in homeland security, said Hartouni. By supporting scientists to do basic research, "we produce a large reservoir of knowledge which we can draw from," he said.

JLAB CONTINUED FROM PAGE 1

have investigated how the quark-gluon soup affects heavy quarks. Some charm quarks are produced in the gold-gold collisions, but the researchers observed that jets of charm quarks coming out of the soup were suppressed.

It seems that the charm quarks get caught up in interactions in the mixture of mostly lighter quarks and gluons. In the RHIC matter, heavy quarks are flowing along with the lighter ones, Jacak said. This is surprising because the charm quarks should be too heavy to be affected by the quark-gluon matter. She likened the phenomenon to a river picking up rocks and carrying them along. Jacak believes this is evidence that the matter being produced at RHIC really is a plasma of unbound quarks and gluons, because quarks bound into hadrons would not be likely to affect charm quarks in this way.

CLEO/QELS Meeting Features Latest Photonics Research

Researchers from around the world presented new results in optics, photonics and their applications at the 2006 CLEO/QELS meeting, held May 21-26, 2006, in Long Beach, California. The meeting is co-sponsored by the Optical Society of America (OSA), the APS Division of Laser Science, and the IEEE Lasers & Electro-Optics Society (IEEE/LEOS).

Three plenary talks featured a mixture of speakers and topics. Don Boroson of MIT Lincoln Lab explained technology that could allow spacecraft to transmit high rates of data via light waves, rather than with conventional radio waves, and how this space technology will influence future laser communications systems. David Payne of the University of Southampton described how lasers that use fiber optics to generate beams may move into many niches that traditional laser designs currently occupy. Richard E. Slusher (Lucent Technologies Inc.) discussed how light's quantum properties are being exploited for use in powerful new encryption, computing, and communications technologies.

Terahertz Biochip for Drug Detection. A Taiwan research collaboration has built a tiny biochip that can instantly identify illicit drugs such as cocaine and amphetamines in their natural powdered form. Researchers simply deposit powder in its natural form into a small, rectangular glass-and-plastic biochip containing some electronic components.

Inside the biochip, a small transmitter beams electromagnetic radiation in the terahertz (THz) range, to which biomolecules are very sensitive. By recording how much radiation the powder absorbs over a range of THz frequencies, the researchers obtain distinctive chemical fingerprints of the biomolecules that make up the powder.

Using this method, the researchers were able to distinguish powders of cocaine and amphetamine from powders of potato starch, flour, and lactose. In addition, the drug's distinctive THz signatures makes them possible to detect even if they were mixed in with an additional ingredient such as flour.

Forensics is not the only application for the terahertz biochip: researchers also believe it may be very useful for molecular biology applications, such as studying the folding patterns of proteins, which would be helpful for designing new drugs.

High-Speed Terahertz Imagers. In an approach that has already improved nondestructive evaluation of the space shuttle and can potentially bring about better detection of weapons and explosives for homeland security, David Zimdars of Michigan-based Picometrix presented a fast and practical real-world system for terahertz (THz) imaging. THz imaging employs a band of electromagnetic radiation between the microwave and infrared spectrum to penetrate objects and look inside them.

NASA engineers have already used the Picometrix design to peer through the layer of spray-on foam insulation on the external fuel tanks of the space shuttle Discovery and inspect it for defects. The terahertz imager is also fast enough for monitoring certain high-speed industrial processes.

The researchers expect it to be possible to develop much faster versions of this system for homeland security applications, such as airline screening of passengers and luggage.

Probing Planetary Atmospheres. In an advance that enables heightened monitoring of planetary atmospheres, for the first time researchers have designed new lightweight laser instruments that make it practical to routinely measure concentrations of atmospheric gases in situ, or in their natural environments. Measuring these gases more widely and frequently will give atmospheric researchers much richer information for studying weather, climate change, and other phenomena on Earth and other planets and moons.

The instruments, known as tunable mid-IR laser spectrometers, produce light in the mid-infrared region, a part of the spectrum to which all atmospheric gases respond in a distinctive fashion.

Using a laser spectrometer on NASA's high altitude WB-57 spacecraft, Christopher Webster of the Jet Propulsion Laboratory and his colleagues have made the first-ever in situ measurements of different water isotopes in and out of the clouds from the troposphere to the stratosphere. This information is providing a wealth of data on the still incompletely understood origin of cirrus clouds, the wispy masses that play a major role in warming Earth.

Record-Breaking Tabletop Microscope. Using state-of-the-art extreme ultraviolet laser technology, Courtney Brewer of Colorado State University and her colleagues have built a tabletop optical imaging system that can reveal details smaller than 38 nanometers in size, a world record for a compact light-based optical microscope. The microscope can keenly inspect nanometer-scale devices designed for electronics and other applications. It will also be capable of catching subtle manufacturing defects in today's ultra-miniaturized computer circuits, where defects just 50 nm in size that were once too small to cause trouble could wreak havoc in the nanometer scales of today's computer chips.

Other state-of-the-art optical microscopes have achieved resolutions as low as 15 nm, but they required the use of large particle accelerators called synchrotrons. This more compact and less expensive system has the potential to become more widely available to researchers and industry.

Orbital Tomography. Electrons orbiting an atomic nucleus are often depicted concretely but incorrectly as little planets circling a miniature sun in crisp trajectories. Quantum mechanics provides a more accurate (but still metaphorical) picture: the electrons can't be depicted directly. Rather, only the probability of their being at certain places near the nucleus can be rendered and even then only as cloudlike blobs. Researchers never had access to actual images of electron clouds–they only calculated them in theory. Thanks to breakthroughs with ultrashort laser pulses, these orbitals can now be imaged directly.

David Villeneuve of the National Research Council of Canada and his colleagues have helped pioneer a method in which a femtosecond laser pulse rips electrons from the periphery of molecules. These electrons, feeling the electric field of the pulsed light, are first repelled but then very quickly recalled to their home molecule by the strong fields of the same pulse which, in its quick cycling, reverses direction. The electrons can then recombine into the parent molecule, and in the process emit extreme ultraviolet light of their own, light which can be used to perform a type of "tomographic" imaging of the molecule, or more particularly its orbitals. Thus the electron is used to image its own domain.

UCSD Physicist Wants Nuclear Weapons Taken Off the Table

Photo credit: Ernie Tretkoff

Jorge Hirsch (center) tries in vain to gain access to the White House.

In September 2005, Jorge Hirsch, a physicist at the University of California San Diego, began circulating a petition opposing US policies that would allow the use of nuclear weapons against Iran. Since September over 700 US physicists have signed the petition. Over 1000 non-US physicists, and over 1000 non-physicists have signed as well.

Hirsch also brought the issue to the attention of the APS and urged the Council to make a statement.(See story on page 1.)

Hirsch has continued his activism against possible preemptive use of nuclear weapons. He led a small protest in front of the White House on April 26.

According to news reports, President Bush has said that all options are on the table in dealing with Iran; he has not ruled out a preemptive nuclear strike.

On April 17, Hirsch wrote a letter to President Bush asking him to take the nuclear option off the table. Thirteen eminent physicists, including five Nobel laureates and three past APS presidents, joined Hirsch in signing the letter.

Hirsch read the letter aloud in Lafayette Park in front of the White House on April 26. A small group of people gathered to listen.

At the protest, Hirsch said that physicists, as members of the profession that built nuclear weapons, are in a unique position to understand the devastation they can cause.

"We are physicists. We know about these weapons," he said.

Hirsch then read aloud his letter to President Bush, which says, in part, "Nuclear weapons are unique among weapons of mass destruction… Using or even merely threatening to use a nuclear weapon preemptively against a nonnuclear adversary tells the 182 non-nuclear weapon countries signatories of the Nuclear Non-Proliferation Treaty that their adherence to the treaty offers them no protection against a nuclear attack by a nuclear nation. Many are thus likely to abandon the treaty. It is gravely irresponsible for the US as the greatest superpower to consider courses of action that could eventually lead to widespread destruction of life on the planet. We urge you to announce publicly that the US is taking the nuclear option off the table in the case of all non-nuclear adversaries."

The entire letter and the list of those signing it can be found at http://physics.ucsd.edu/petition/physicistsletter.html.

Hirsch also read the APS Council statement as part of the protest.

After reading the letter over a bullhorn in front of the White House, Hirsch attempted to deliver the letter to President Bush, but guards at the White House gate did not allow him to do so. He said he would not give up, and planned to appear at Lafayette Park every Wednesday until his message is heard.

INTELLIGENCE CONTINUED FROM PAGE 4

during my fellowship tenure, I went on to chair the Intelligence Community's Directed Energy Weapons Subcommittee from 1990 to 1998, and was awarded the National Intelligence Medal in 1999 for work done while in that position. Hopefully, more physicists will be selected for this honor and its unique training experience.

Ronald I. Miller
Huntsville, AL

Editor's Note: Our sources in the DNI's office tell us that the DNI Fellowship is not simply the DCI Fellowship with a new name. It is a new program with different rules.

DNA CODE CONTINUED FROM PAGE 4

sophisticated code in molecular systems rewrite itself in response to environmental stress? Why couldn't the "intelligent design" be in the cells as part of the DNA-RNA interaction with the chemical and physical environment? Why not hypothesize that a living cell could recreate itself by rewriting its DNA much like it rewrites an isolated portion in order to create an antibody? Perhaps biological states are selected by environmental inputs. This hypothesis is testable.

Isn't there anyone out there who thinks this is a fascinating possibility? If only I were younger!

J.W. Lane
Tallahassee, FL

NUCLEAR WEAPONS CONTINUED FROM PAGE 1

In addition, the Council provided background information to place the statement in context. It reads:

"The American Physical Society notes that any policy by the United States to use nuclear weapons against non-nuclear weapon states threatens to undermine the Non-Proliferation Treaty regime. The current US nuclear-use policy, stated in 1995, and reiterated in 2002, reads:

'The United States reaffirms that it will not use nuclear weapons against non-nuclear-weapon state-parties to the Treaty on the Non-Proliferation of Nuclear Weapons, except in the case of an invasion or any other attack on the United States, its territories, its armed forces or other troops, its allies, or on a state toward which it has a security commitment carried out, or sustained by such a non-nuclear-weapon state in association or alliance with a nuclear-weapon state.'"

A statement on nuclear use was recommended to Council by the APS Panel on Public Affairs (POPA). One factor in POPA's decision to bring this issue forward was the strong advocacy on its behalf by Jorge Hirsch of the University of California, San Diego (*see story, above*).

PLASMA CONTINUED FROM PAGE 3

lab-based jets are a mere 20 inches tall, and while he admits it is not an exact model, nonetheless they exhibit the same underlying physics, and can therefore provide insight into the mechanisms at work in the large-scale jets.

Magnetic lines of force are believed to both drive astrophysical jets and cause their collimated profile. The lab-sized jets are produced through magnetic lines of force, generated via lots and lots of power: on the order of 200 million watts in the laboratory simulations. Bellan's lab cuts down on those costs by using short, extremely powerful magnetic pulses every few seconds.

To create his plasmas in the laboratory, Bellan uses a copper disk and an annulus to simulate the accretion disk that surrounds a black hole. A coil provides the initial "seed" magnetic field for the confined gas, which can be broken down to form a plasma by the judicious application of several kilovolts of electric current across the disk and annulus. The current first flows along the path created by the seed magnetic field, creating a pattern that looks for all the world like "spider legs." The attractive forces concentrate the current into a jet, and the repulsive magnetic forces speed it up so the spider legs get bigger and bigger. Eventually the jet undergoes a "kink instability," coiling up like a twisted telephone cord and shooting outward.

University of Iowa physicist John Goree is creating small-scale versions in the lab of so-called "dusty plasmas," and using them to simulate and study the propagation of waves through the plasma–which appear to behave much like the shock waves generated along the crusts of neutron stars (see story, page 5). Dusty plasmas make up the tails of comets and the rings of Saturn.

Goree creates his mini-dusty plasmas by dropping polymer microspheres–the "dust"–into a glow discharge plasma. The dust can absorb electrons and ions because its particles are so much heavier, giving the dusty plasmas a negative charge and changing their behavior. Goree then videotapes the particles' behavior, which mimics that of dusty space plasmas.

ANNOUNCEMENTS

Estate Planning Handouts Now Available

In addition to the many research talks at the 2006 March meeting in Baltimore, an estate planning session was once again offered for attendees and local members. Led by Jerry McCoy, an attorney from the DC area well-known for expertise in estate tax law, the session provided APS members with tips and tax savings ideas for use in planning for the long term distribution of their property to family, friends and charitable interests. Handouts from the session, including informational brochures on a broad range of estate planning topics, are available to all interested members from Darlene Logan at logan@aps.org.

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

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

Optics in the relativistic regime

G. Mourou, T. Tajima and S. Bulanov

With advances in laser technology, peak field intensities have increased to the point where electrons are accelerated to relativistic velocities within a single optical cycle. This article reviews the techniques for producing ultrahigh intensities highlighting the fundamental and technological limitations. The ultimate conceivable goal with present laser media is the zettawatt laser, which would have a peak intensity of 10^{29} W/cm^2. Also a description of present and future scientific and technological applications extending the realm of optics from the eV to conceivably the TeV range is presented.

RELIGION CONTINUED FROM PAGE 4

consequence of nature is considered blasphemous. Human beings have thought about religion for several thousand years longer than anyone has thought about physics. There is far more to "religion" than the claims made in its name by the Taliban or by the intelligent design proponents.

I am offended by the self-righteous arrogance of many of my colleagues, especially in physics, who make derogatory statements about things about which they have obviously not thought enough and about which they are inadequately informed. I doubt that Krauss would attempt to perform neurosurgery with what he knows, or whether he would be able to pass peer review for a biology grant. As much as I concur with his damnation of ID, I still question whether he understands evolution sufficiently well to provide a cogent summary of why it is the only scientific explanation or what exactly it explains.

When someone talks about "religion" and selects the most brutish and the most ignorant people claiming to be religious to stereotype religion in general, we are not faced with science; we are faced with demagoguery. I seriously doubt whether any self-respecting editor of a peer-reviewed scientific publication would recommend publishing unsubstantiated statements about religion based on a sample that is as biased as the worst examples of superstition.

Walter Schimmerling
Arlington, VA

GEORGE VALLEY CONTINUED FROM PAGE 4

bombs on "targets of opportunity" with the Norden optical bombsight. George was an organizer also of the Radiation Laboratory series of books. The APS Prize is most appropriate and much appreciated.

Britton Chance
Philadelphia, PA

EVOLUTION CONTINUED FROM PAGE 4

accomplishments. They have no problem with science in general and have great respect for scientific methodology. They have one characteristic in common, however. They refuse to march in lock-step with a theory that they believe has not yet been fully tested.

The article's general belligerence doesn't help. A temperate approach in any discussion always makes it more believable. When science becomes an emotional issue, objectivity is lost. The great danger in an emotional embrace of any theory is that if a crack appears in the theory it is not noticed. Emotion blinds one from seeing its faults. What if Newton had demanded that his laws of motion be enshrined and never be challenged? The answer is simple: we would have never seen Einstein's theory of relativity.

Science has a very strong case for evolution. The evidence is impressive. Science doesn't have to depend on hyperbole to make its case. And science needn't be as nervous as Krauss makes it appear to be. Let's not blow it by becoming hysterical. Religion, if we dare use this term in a collective manner, has a difficult time proving its case. Its evidence is purely subjective–which doesn't mean that it is not true–and each person must judge Bible creation for himself or herself and come to his or her own conclusion. As Krauss accurately states, its rightness or wrongness cannot be fought out in the scientific arena. But let's not elevate the theory of evolution into being dogma so we defend it by edict and not by test. That would not be following scientific methodology.

Leonard C. Aamodt
Harrisonburg, VA

INSIDE THE BELTWAY CONTINUED FROM PAGE 3

rage in opinion polls. On May 9, President Bush, whose approval rating has been in free fall all year, hit a new low of 31% in a USA Today/Gallup poll (18% on his handling of gas prices). But he was well above the 23% that Congress garnered.

If this were the first time soaring oil prices threatened our way of life, I could understand the hand-wringing, the angst and the political paralysis. But it isn't.

In the days before Lee Raymond was at ExxonMobil's helm and the company was called Esso, McCann Erickson, a premier Madison Avenue firm, helped the Standard Oil Company of New Jersey launch one of the most productive advertising campaigns in the history of corporate America. The slogan was, "Put a tiger in your tank."

That was in 1964. It was an era when all you needed was a 389 cubic inch engine and sex appeal to sell a car, when Detroit sat on top of the world, and what was good for General Motors really was good for America. Back then gas was cheap, or at least it seemed so, and every eighteen-year-old filled up on premium, just to impress his girl, even if his car didn't need it. Gas was also mostly an American product: we imported less than 25% of the oil we used.

Less than a decade later, on October 6, 1973, half a world away from Main Street, Egypt and Syria launched another campaign, a surprise military offensive against Israel on the Jewish high holy day of Yom Kippur. With American assistance, Israel, after initially suffering significant losses, pushed the invading Arab armies back across the borders. The Organization of Petroleum Exporting Countries (OPEC), dominated by Arab nations, struck back by imposing an oil embargo on the United States.

By then, we were importing 35% of our oil, and within hours, the price of a barrel of black gold shot up 70%. Two months later it had doubled again, sending gasoline prices soaring to more than $3 a gallon in 2006 inflation-adjusted dollars.

Responding to consumer pain, Congress enacted the Corporate Average Fuel Economy (CAFE) Standards in 1975, and for the next two decades auto efficiency improved dramatically, and the size of cars shrank. But as gas prices gradually fell to less than a dollar a gallon, the public and politicians lost interest in serious energy reform, even as we became 65% dependent on oil imports. The automakers discovered that they could boost their bottom lines by selling gas guzzling SUV's and Hummers that carried high profit margins. And consumers were happy to oblige–until now.

Gasbuddy might be able to save you half a buck a gallon, but you're still going to pay about $75 to fill up your Lincoln Navigator. So what to do? In the short term, consumers are going to have to pay the price for poor public policies, lousy leadership and their own extravagance. And members of Congress may well find themselves paying the price at the real polls in November.

Long term, we must focus on policies that promote efficiency and conservation, spend money on research to make alternate sources of energy economically and environmentally acceptable and come to the realization that the true cost of gas is far higher than the price you pay at the pump. If you include the hundred plus billions of military dollars we have had to spend each year to keep the foreign wells pumping and the sea lanes open, gas hasn't been cheap for years.

ORIGIN OF LIFE CONTINUED FROM PAGE 4

rapidly), the Earth did not have a reducing atmosphere, there is no evidenceof a prebiotic soup, and the earth was under heavy meteoritic bombardment during that period, hostile to life. A recent edition of *Science* (Vol 312, 14 April 2006, pg 179) reports on the current debate whether deep sea vents, or warm little ponds and any number of other chemical stew pots could have assembled molecules leading to life. And then come the astrobiologists who speak of panspermia, with meteorites bringing to Earth the first amino acids. This not considered controversy?

Add to this the next big puzzle: where, when and how (and even if) the earliest hominids became homo sapiens with "a living soul", and you would immediately be getting into another major controversy between ontological naturalism and a religious world view.

Science continually raises philosophical questions that go beyond the competence or purview of science, specially those dealing with origins.

I wonder if the real driving force behind ID-ers is not whether it should be called science or not, but rather the fact that evolutionists like Dawkins, and many others, use evolution to make philosophical statements, such as "the Darwinian world view makes belief in God unnecessary or impossible". The issue is not between creation vs evolution but rather creationism vs evolutionism, neither of which is science!

Kenell J. Touryan
Indian Hills CO

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US Nuclear Threat Can Enhance Stability

On an occasional basis, *APS News* will publish conversations with individuals deeply involved in policy issues relevant to the APS membership. In this first conversation, Francis Slakey, Associate Director of Public Affairs and Jennifer Ouellette, *APS News* Associate Editor, met with Admiral Richard Mies, Commander in Chief of Strategic Command, the operational commander of US nuclear forces, from 1998 until 2002. Mies helped shape post-9/11 US nuclear strategy.

Q: *What is the nation's nuclear use policy, as you understand it?*

A. The primary value of nuclear weapons is not in their use; it's in the threat or potential of their use. They are primarily instruments of war prevention rather than war fighting and in my estimation, serve only as weapons of last resort when deterrence has failed. Our nation's nuclear weapons policies are intended to deter potential adversaries' use of weapons of mass destruction and even large-scale conventional aggression against the US and our allies. In the wake of the Cold War, our Nation is attempting to develop a deterrent strategy with lower nuclear salience, reduced warhead numbers and less adversarial character.

Q: *What is the chain of command that oversees the potential use of nuclear weapons?*

A. Only the President has the authority to direct the use of a nuclear weapon. The situations that might involve the potential use of nuclear weapons are very scenario-dependent; but as a general rule there is a conference involving a number of both senior military and civilian participants, including the commander of US Strategic Command, the Chairman of the Joint Chiefs, and the Secretary of Defense. The purpose is to assess the situation and discuss with the President a wide range of strategic options available to him including but not necessarily limited to potential nuclear options.

Q: *Could you explain the role of "calculated ambiguity" in deterrence?*

A: The concept of deterrence is to create uncertainty in a potential adversary's mind, such that he can't be fully confident that he can achieve his objectives without a strong retaliation from the US with unacceptable consequences to him. If you can create enough uncertainty in his mind, then deterrence is likely to be successful. The calculated ambiguity–under what circumstances and when and how the President may authorize the use of strategic capabilities including nuclear weapons–plays a large role in fostering that uncertainty.

Q: *The 2005 draft of the US military's Doctrine for Joint Nuclear Operations states: "Geographic combatant commanders may request presidential approval for use of nuclear weapons for a variety of conditions. Examples include an adversary intending to use weapons of mass destruction against the US." Is this saying the US might preemptively use nuclear weapons against a non-nuclear state? Does the Doctrine represent a change in US policy?*

A: I don't think there's been any significant change in our national policy in that respect. Fundamentally, nuclear weapons will always remain a weapon of last resort in our national strategy. The ability to pre-empt has always existed but has never made any rational sense especially during the Cold War. I believe we would only consider pre-emption under very extraordinary conditions: where we had no other capabilities at our disposal to prevent dire consequences from happening to the US or our allies, and where we also had perfect intelligence that would enable us to be absolutely certain that unless we used a nuclear weapon, this dire event would happen. I view nuclear pre-emption as a very implausible option considering the wide range of non-nuclear options available and the imperfect nature of our intelligence.

Q: *The enemy the US faces today includes terrorist organizations and states that sponsor terrorism. How does nuclear deterrence fit into this new context?*

A: Deterring terrorism is a greater challenge than deterring a specific nation-state. You may not be able to deter an individual suicide bomber from ultimately completing his mission; but, there are ways to think about deterring terrorism as a network–including state sponsors, terrorist organizations and infrastructures, and terrorist funding sources. We must think about how to tailor our capabilities and policies to deter a more uncertain, faceless, and more opaque spectrum of adversaries. There are a number of diplomatic, economic, and military means of achieving deterrence; it's far broader than nuclear weapons. And it's far broader than a national concern. Many European countries are vulnerable to terrorism. So I think it's a concern that we all share. Again, the goal is to create uncertainty in our potential adversaries' minds as to whether they would be able to achieve their objectives and still survive as an entity. A state that sponsors terrorism against the US would have to be concerned about the possibility that the US may retaliate in some unacceptable way. Terrorist organizations that attempt to employ WMD could also anticipate a very strong international response that may not be conducive to the survival of their organization.

Q: *During the Cold War the weapons were designed for a massive exchange against the Soviet Union. Some military analysts claim that the yields of these weapons are so high that a state that sponsors terrorism might assume we'll never use them.*

A: I think there's a grain of truth in that. It's a very different world today. Deterrence is a function of credibility and will. A potential adversary must believe you have a credible capability, and also must believe that you have the will to use that capability. There is a legitimate concern that today we lack some capabilities to ensure our deterrent remains credible against emerging threats.

Admiral Richard Mies

This is the great paradox of nuclear weapons: you need weapons with credible capabilities not so you increase the likelihood of their use, but rather, so you have a more credible deterrent and thereby never have to use them. Of what deterrent value are weapons that lack credible capability? The Cold War stockpile we have inherited was designed largely on the threat of relatively large-scale attacks of relatively high yield weapons with moderate accuracy and reasonable reliabilities. That world no longer exists today. Hence, the preservation of our capability to adapt our deterrent forces to a rapidly changing and unpredictable future is critical. In my view, we need to adapt our existing forces to provide a limited number of weapons with combinations of distinct attributes such as lower yield, higher accuracy, greater reliability, greater stand-off capability, and improved earth-penetrating capability. In so doing, we could tailor any response to a wider range of potential adversaries under varying scenarios. For example, improved accuracy would enable us to employ lower yields and minimize the potential of greater collateral damage.

Q: *The Moscow Treaty requires the US to reduce its arsenal to below 2200 operationally deployed warheads by 2012. Do the improvements in capabilities you describe fit within those numbers?*

A: Easily. This doesn't require new warheads. We can adapt the existing stockpile and the existing delivery systems to provide those capabilities at reasonable cost. But I think there's an over-fascination with numbers of warheads rather than their capabilities. There is a naive and mistaken belief that the "nuclear danger" is directly proportional to the number of nuclear weapons and, accordingly, lower is inevitably better. As we reduce our strategic forces to lower levels, numerical parity or numbers alone become less and less important. We must preserve sufficient deterrent capability to respond to future challenges, to provide a cushion against imperfect intelligence and surprises, and to preserve a reconstitution capability as a hedge against unwelcome political or strategic developments. At the end of the day, capabilities are far more important then simply numbers. Ten large yield warheads with 90% reliability and moderate accuracy count the same as ten lower yield warheads with near-perfect reliability and GPS-like accuracy. If you had your choice, which would you prefer as a deterrent?

Q: *Rep. David Hobson (R-OH), Chair of the Energy and Water Appropriations Subcommittee, recently said, "We cannot advocate for nuclear nonproliferation around the globe while pursuing more usable nuclear weapons options at home." Do you share his concern?*

A: I strongly disagree with the contention that nuclear weapons are more usable just because they have improved capabilities and are tailored to a broader range of threats. The history of our stockpile was one of improved capabilities throughout the Cold War. Those weapons helped keep the Cold War cold. Nuclear weapons with tailored capabilities are more likely to deter your adversaries than simply maintaining a stockpile that was designed against a very different Cold War threat. The threshold for using a nuclear weapon is very, very high. It's a taboo that has existed for over 60 years, and it is one that no President will break lightly. These will always be weapons of last resort.

Again, the great paradox of nuclear deterrence is that we must have credible and hence usable weapons so we never have to use them. Consider the attached chart which roughly illustrates the percentage of human deaths as a result of warfare over a long history (see chart).

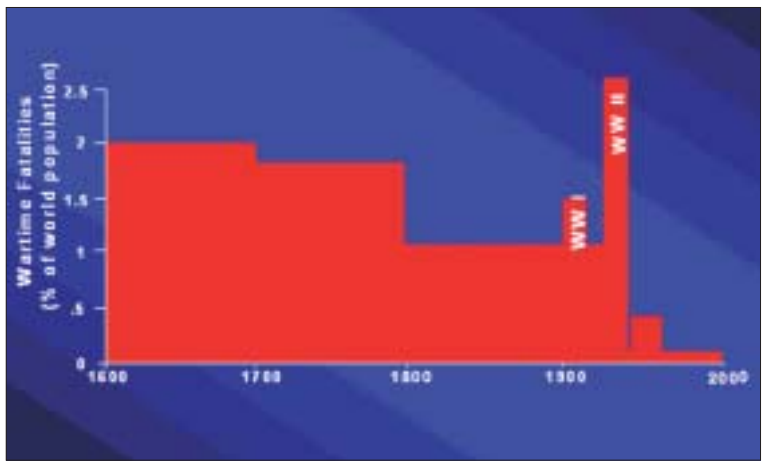

Chart of the percentage of human deaths as a result of warfare

Around 1945, there's a dramatic decrease in deaths in combat as a percentage of the world's population. Warfare has fundamentally changed in the nuclear era. In earlier history, warfare didn't have the potentially dire global consequences that it has today. Today, the level of conflict may escalate beyond a nation's control and lead to unacceptable consequences, giving nations pause. I would argue that one of the primary reasons for the dramatic decrease is the existence of nuclear weapons has caused great nations to behave more responsibly and to even seek to avoid conventional war for fear it could potentially escalate into a nuclear one.

Q: *Does developing a new inventory of nuclear weapons with a different set of capabilities violate the terms of the nonproliferation treaty: that those countries with weapons should be working toward disarmament?*

A: Improving some of the capabilities of the stockpile is not in conflict with the long-term objective of total disarmament. Frankly, I'm not sure that the world will ever be capable of achieving that idealistic objective. Nuclear weapon technology cannot be disinvented. Imagine a world where no one had nuclear weapons, except for one rogue nation that acquired a small number of nuclear weapons. That would be a very dangerous world compared to the one we presently live in. Even though there are a larger number of nuclear weapons, our situation is far more stable. As we move toward this idealistic goal of disarmament, we need to be realistic and never lose sight of the principle of enhancing stability. That ought to be the over-riding criterion. As Sir Michael Quinlan has stated: "The absence of war between advanced states is a key success. We must seek to perpetuate it. Weapons are instrumental and secondary; the basic aim is to avoid war. Better a world with nuclear weapons but no major war than one with major war but no nuclear weapons."

Q: *North Korea and Iran are moving toward the development of nuclear weapons. Do nonproliferation policies need to be changed or strengthened?*

A: There needs to be continued assertion and reinforcement of those principles. The nonproliferation regime has had a fairly good record despite Iran and North Korea. To the degree that we can maintain a credible nuclear deterrent without underground testing, I support the current moratorium. But there's a great danger when you lock yourself into treaties that attempt to establish absolutes such as the Comprehensive Test Ban Treaty. There are certain legitimate scenarios where we might have to perform a limited test if we had grave concerns about the reliability of our stockpile. It's not that we want to conduct nuclear tests. But we've always held as a principle that we will take whatever actions are prudent and necessary to defend ourselves. As a nation, we are very reluctant to surrender that right of self-protection. We are wary of locking ourselves into international agreements that could constrain us should we need to exercise that right, in some unforeseen world that we can't predict today.

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.