Serious Consequences Loom If FY07 Budget Is Frozen

Instead of the expected increases, federal funding for physical sciences for Fiscal Year 2007 may be frozen at FY06 levels because Congress failed to pass a budget for FY07. This will have severe consequences for the science and education programs in the United States, including potential cutbacks in operations at several major national labs, delays in some scheduled projects, and reductions in the number of new research grants.

Expected budget increases for the physical sciences were put on hold last fall when Congress adjourned having passed only two appropriation bills, for homeland security and having passed only two appropriations in the number of new research grants when it passes the yearlong resolution. This would allow the new Congress to turn its attention to the FY08 funding request scheduled to be released in early February. After decades of relatively flat funding, FY07 was expected to be a good year for physical science funding. President Bush’s proposed American Competitiveness Initiative, which had bipartisan support, would have doubled funding for science over ten years. For FY07, the administration had requested a 14% increase for the Department of Energy Office of Science and a 7.8% boost for the National Science Foundation. Instead, without action by Congress, funding will be held at FY06 levels, which was a poor year for physical science funding. The $3.5-billion FY 2006 appropriation for the DOE Office of Science rep. tations bills, for homeland security and having passed only two appropriations in the number of new research grants when it passes the yearlong resolution. This would allow the new Congress to turn its attention to the FY08 funding request scheduled to be released in early February. After decades of relatively flat funding, FY07 was expected to be a good year for physical science funding. President Bush’s proposed American Competitiveness Initiative, which had bipartisan support, would have doubled funding for science over ten years. For FY07, the administration had requested a 14% increase for the Department of Energy Office of Science and a 7.8% boost for the National Science Foundation. Instead, without action by Congress, funding will be held at FY06 levels, which was a poor year for physical science funding. The $3.5-billion FY 2006 appropriation for the DOE Office of Science rep.
California, Berkeley, on analyzing William Perry. Says NAE President by a distinguished panel, chaired and mysteries. So it's going to keep us busy for a long time."

“Supersymmetry is a vital part of string theory, so the LHC doesn’t find it, that would argue strongly against string theory. If it is observed, you can say that string theory has not been disproven, but that it has been validated.”

Raymond Jeanloz, University of California, Berkeley, on on leave, professor of geophysics and Earth system science at the Lawrence Livermore National Laboratory, said that the LHC is a "unique and essential tool for understanding the fundamental nature of matter and the universe." He added that the LHC is "a fantastic machine that will allow us to probe deep into the heart of the universe."
The ITER Agreement—Four Months for Me and Counting

By Michael Roberts

FEBRUARY 2007 3

The agreement that was recent enough to be worth writing about, has already passed four months. For the International Atomic Energy Agency (IAEA), it is a milestone in the international fusion program. It was signed by seven major scientific representatives of the United States, Russia, the European Union, China, India, South Africa, and South Korea. The agreement was negotiated for nearly two years to iron out the details of the international project to construct a full-sized fusion reactor, ITER (International Thermonuclear Experimental Reactor).

ITER was initially proposed in the early 1980s. In 1988, the United States, European Union, and Japan signed an agreement to work together toward a common, internationally owned fusion research facility. In 1991, the Soviet government and China, South Africa, and South Korea joined the ITER consortium. In 1995, the ITER Agreement was signed, providing for the establishment of ITER as a joint project of seven Parties: Australia, China, France, Germany, Japan, Russia, and the United States. The ITER Agreement was revised in 2000.

The ITER Agreement, the most significant international scientific collaboration since the Marshall Plan, represents a milestone in global fusion research. It is the culmination of a quarter-century of continuity for US-American nuclear scientists, industry personnel, and governmental negotiators. The ITER Agreement is a joint initiative to construct a large, high-temperature tokamak to demonstrate the scientific and technical feasibility of achieving fusion burn, a process that releases energy from the fusion of atomic nuclei. This process occurs naturally in stars.

The ITER Agreement is a joint agreement that must be implemented by all the Parties. It provides for the joint construction of ITER, a joint research program, a joint scientific program, and a joint administrative body. The ITER Agreement is a joint agreement that must be implemented by all the Parties. It provides for the joint construction of ITER, a joint research program, a joint scientific program, and a joint administrative body.
The Virtues of Virtual Experiments

From across the pond comes the sad news that the University of Reading is phasing out its physics department and its undergraduate laboratories. “Strains and stresses” is the official voice, but the British physics community, led by the University of Reading and the University of Oxford (UK equivalent of the APS), the university’s ruling council voted decisively last fall to close the departments and laboratories. Those who are now completing their undergraduate studies have had a chance to graduate.

Philip Diamond, assistant director for Research in Physics and Science at the IOP, noted that “the Higher Education Funding Council for England has now announced an additional £75m to support very high-cost subjects, including physics, from 2007-08 over three years. The funding is not enough to save Reading’s physics department but the institute hopes that it will prevent more redundancies.”

Diamond’s statement acknowledges the fact that teaching physics is not as attractive a career choice as, perhaps, teaching, say, English literature. In major research universities, the extra expense is due in large part to the cost of maintaining and staff time for all the teaching laboratories.

Many smaller American colleges and universities, however, do not offer physics majors, even though they do have majors in chemistry and biology. Physics is squeezed between the high cost of teaching and the typically lower enrollments of majors compared to its sister sciences. In 2004, about 23,000 students were awarded to students in colleges or universities that did not have a physics major.

A ray of hope in this pernicious situation may come from a paper published in the recently established open access and open collaboration journal of Special Topics: Physics Education Research. The abstract of the paper, by N. D. Finkelstein et al. (Phys. Rev. ST Phys. Educ. Res. 1, 011003 (2005)), is worth quoting in full:

“This paper examines the effects of substituting a computer simulation for real laboratory equipment in the second semester of a large-scale introductory physics course. The direct current circuit laboratory was modified to compare the effects of using computer simulations with the effects of using real light bulbs, meters, and wires. Two groups of students, who used real equipment and those who used a computer simulation that explicitly modeled electron flow, were compared in terms of their mastery of physics concepts and skills with respect to the traditional laboratory. Although the simulated equipment outperformed their counterparts both on a conceptual survey of the domain as well as in coordinated tasks of assembling a real circuit and describing how it worked. In addition to being better pedagogically, the simulated laboratory is, of course, also less expensive to operate. Almost all undergraduates at these days have their own computers. Although some computers should be made available in the computer laboratory to allow most of the students to log in and do the simulated experiments from their own offices or dorm rooms, halls. There will be no need for staff to make sure the equipment is functioning, that proper safety procedures are being followed, and that all the other time-consuming but non-educational aspects of running an instructional laboratory are taken care of. An additional advantage set aside for laboratory work in introductory courses can be reduced to practically nothing.”

Adding these facts to Schrödinger’s experiment and you can begin to appreciate uncertainty. For example, most cat molecules know which their friends are, and we can assume that Schrödinger is not among them. How long will it take him to capture the cat molecules and jam them into the box? We cannot predict. For the sake of argument, however, let’s say it takes four hours—an optimistic estimate, considering that Schrödinger will have to stop for first aid, possibly a transfusion. What if some radioactive particle takes off before the cat molecules can be introduced? Surely Schrödinger has armed the poison gas mechanism in advance, since once any cat mass is dropped into a box, slamming and securing the lid is the only priority. But what if he left the lid open while pursuing the cat? Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas.

Schrödinger is not among them. But what if he leaves the lid open while pursuing the cat? Is the gas poisonous to humans? In this arrangement, once the cat mass is dropped into a box, slamming and securing the lid is the only priority. But what if he leaves the lid open while pursuing the cat? Is the gas poisonous to humans? In this arrangement, once the canister of poison is in the box, Schrödinger has to stop for first aid, possibly a transfusion. What if some radioactive particle takes off before the cat molecules can be introduced? Surely Schrödinger has armed the poison gas mechanism in advance, since once any cat mass is dropped into a box, slamming and securing the lid is the only priority. But what if he leaves the lid open while pursuing the cat? Is the gas poisonous to humans? In this arrangement, once the cat mass is dropped into a box, slamming and securing the lid is the only priority. But what if he leaves the lid open while pursuing the cat? Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas. Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas.

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The Uncertainty of Cat Molecules

Physicists keep uncovering evidence that unpredictability rules the universe. Molecules and atoms are not solid bits circling one another in a cosmic little house, but with fuzzy edges and minds of their own. Newton’s ordered universe is dead. This is not news to me. I am self-employed, and I live with cats. For those who find uncertainty hard to grasp, the theoretical physicist Erwin Schrödinger some years ago illustrated it with a thought experiment in the form of a thought experiment in a box.

In a box, place a bit of radioactive material, a Geiger counter, a canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas. Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas. Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas. Is the gas poisonous to humans? In this arrangement, once the canister of poison gas, and a charge device. Connect the Geiger counter to the charge device to the canister, so that if a particle emitted from the radioactive isotope hits the Geiger counter, it triggers the charge, boosts the cap on the canister, and releases the poison gas.

Schrödinger’s anatomy. It’s that all went as planned—the random particle took off, the trigger worked, the cap blew, and the cat molecules gasped and died. This hypothesis seems to assume that the cat molecules went to sleep the instant the lid snaps shut. How probable is that? Might not the cat molecules have attacked the Geiger counter or tried to snap the gas counter’s neck? Couldn’t they have died of fright? And about the effect of cat urine on the charge device? Or let’s say the cat molecules survive. Can we predict what will happen when Schrödinger opens the box? The effect of confinement on cat molecules is well known. Odds are that when the box is opened, the cat molecules will instantly launch the cat mass directly at Schrödinger’s eyes. But the cat molecules might travel at a more vulnerable part of Schrödinger’s anatomy. It’s his eyes, after all.

Schrödinger’s Cat clearly shows that Schrödinger was a pathological—by far and away the most, and so, of course, did cats. He did, however, get along reasonably well with Mrs. Schrödinger. Otherwise, we would have Schrödinger’s Wife. And there’s no telling what that thought experiment might have illuminated, no telling at all.

---Carole Simon

About 120 physicists gathered at APS headquarters in December to sort the almost 7000 abstracts submitted to the APS March Meeting that will take place in Denver, March 5-9. Action among the big board got rather intense as representatives of the different divisions, topical groups and forums jockeyed for position. In the end, though, no one was seriously injured, all the sessions were filled, and another March Meeting was well on its way to success.

Viewpoint...
Plumbing the Electron’s Depths

Careful observation of a single electron in an atom trap over a period of several months has resulted in the best measurement yet of the electron’s magnetic moment and an improved value for the fine structure constant, the parameter which sets the overall strength of the electromagnetic force.

The theory of quantum electrodynamics (QED) predicts that an electron is perpetually grappling with virtual particles emerging briefly from the surrounding vacuum. In the absence of these interactions, the magnetic moment of the electron (referred to by the letter $g$), which relates the size of the electron’s magnetism to its intrinsic spin, would have a value of 2. But direct measurements of $g$ show that it is slightly different from 2. The finer these measurements become, the better one can probe the quantum nature of electrons and QED itself. Furthermore, if the electron had structure this too would show up in measurements of $g$.

To gain the greatest possible control over the electron and its environment, Gerald Gabrielse and his students Brian Odom and David Hanneke at Harvard University create a macroscopic artificial atom consisting of a single electron executing an endless looping trajectory within a trap made of charged electrodes—a central, positively-charged electrode and two negatively-charged electrodes outside, in an attempt to keep the electron producing a magnetic field. The combined electric and magnetic forces keep the electron in its circular “cyclotron” orbit. In addition to this planar motion, the electron wobbles up and down in the vertical direction, the direction of the magnetic field. The heart of the Harvard experiment is to explore these two motions—the circular motion, which conforms to quantum rules, and the vertical motion, which conforms to classical physics—in a new way.

It is this masterful control over the electron’s motions and the ability to measure the energy levels of the electron’s artificial quantum environment that allows the Harvard group to improve the measurement of $g$ by a factor of 6 over previous work. The new uncertainty in the value, set forth in an article in Physical Review Letters, is now at the level of 0.76 parts per trillion.

No less important than $g$ is alpha. By inserting the new value of $g$ into QED equations, and to the improved QED calculations of very high accuracy, the experimenters and theorists together determined a new value for alpha, one with an accuracy ten times better than available from any other method. This is the first time a more precise value of alpha has been reported since 1987. The new alpha, published in a companion article in Physical Review Letters, has an uncertainty of 0.7 parts per billion.

The measured value of $g$ can also be used to address the issue of hypothetical electron constituents. Such subcomponents, the new $g$ measurement shows, could be no lighter than 130 gigaelectronvolts.


Dark Energy at Redshift Z=1

Dark energy, the unidentified force that’s pushing the universe to expand at ever faster rates, was already at work as early as nine billion years ago, scientists reported in November. New Hubble Space Telescope sightings of distant supernova explosions support the explanation of dark energy as the vacuum of the universe whose density has stayed constant throughout the universe’s history, the scientists said.

Using the Hubble, a team led by Adam Riess, an astrophysicist at the Space Telescope Science Institute and at Johns Hopkins University has now observed 23 new supernovae dating back to 8 to 10 billion years ago. Until now, astronomers had only seen seven supernovae from that period, Riess said, too few to measure the properties of dark energy. The data show that the repulsive action of dark energy was already active at that time, and are consistent with a constant energy density—in other words, with an energy of the vacuum that does not dilute itself as the universe expands, eventually fueling an exponential growth of the universe.

More complicated models with non-constant energy density—including a class known as quintessence models—are not completely ruled out, Riess said during the press conference: the new data still allows for variations of up to 45 percent from constant density. For more recent ages, dark energy is known to have been constant up to a 10 percent variation.

The new data also confirm the reliability of supernovae as signposts of the universe’s expansion, Riess said.

First Direct Evidence of Turbulence in Space

Turbulence can be studied on Earth easily by mapping such things as the density or velocity of fluids in a tank. In space, however, where we expect turbulence to occur in such settings as solar wind, interstellar space, and the accretion disks around black holes, it’s not so easy to measure fluids in time and space. Now, a suite of four plasma-watching satellites, referred to as Cluster, has provided the first definitive study of turbulence in space.

The fluid in question is the wind of particles streaming toward Earth from the sun, while the location in question is the region just upstream of Earth’s bow shock, the place where the solar wind gets disturbed and passes by Earth’s magnetosphere. The waves in the shock-upstream plasma, pushed around by complex magnetic fields, are observed to behave a lot like fluid turbulence on Earth.

One of the Cluster researchers, Yasuhiro Narita of the Institute of Geophysics and Extraterrestrial Physics in Braunschweig, Germany, says that the data is primarily in accord with the leading theory of microturbulence, the so-called Kolmogorov’s model. (Narita et al. Phys. Rev. Lett. 97, 191101, 2006)

A New Triumph for Inflation

The inflationary bang big model has passed a crucial test as scientists working on the Wilkinson Microwave Anisotropy Probe released a long-awaited second set of data at a press conference held March 17.

The earlier release of WMAP data 3 years ago nailed down several grand features of the universe that had previously been known only very roughly, including: the time of recombination (380,000 years after the big bang, when the first atoms were formed); the age of the universe (13.7 billion years, plus or minus 200 million years); and the makeup of the universe (with dark energy accounting for 73 percent of all energy).

Since that 2003 announcement, WMAP researchers have painstakingly worked to reduce the uncertainties in their results. The new result in the March 17 announcement, based on three years of data, was the release of a map of the sky containing information about the microwaves’ polarization.

The microwaves are partly polarized from the time of their origin (emerging from the so-called sphere of last scattering) and partly polarized by scattering, on their journey to Earth, from the pervasive plasma of mostly ionized hydrogen created when ultraviolet radiation from the first generation of stars struck surrounding interstellar gas.

WMAP now estimates that this recombination, effectively denoting the era of the first stars, occurred 400 million years after the big bang, instead of 200 million years as had been previously thought. The main step forward is that smaller error bars, courtesy of the polarization map and the much better temperature map across the sky—with an uncertainty of only 200 billionths of a Kelvin—provide a new estimate for the inhomogeneities in the CMB’s temperature.

The simplest model, called Harrison-Zeldovich, posits that the spectrum of inhomogeneities should be flat; that is, the inhomogeneities should have the same variation at all scales. Inflation, on the other hand, predicts a slight deviation from this flatness.

The new WMAP data for the first time measures the spectrum with enough precision to show evidence for inflation rather than the Harrison-Zeldovich spectrum—a test that was long-awaited as inflation’s smoking gun. (Papers available on the NASA web page: http://map.gsfc.nasa.gov/m_mm/pub_papers/threeyear.html)

Two-Dimensional Light

Two-dimensional light, or plasmons, can be triggered when light strikes a patterned metallic surface. Plasmons may well serve as a proxy for bridging the divide between photonics (high throughput of data but also at the relatively large circuit dimensions of one micron) and electronics (relatively low throughput but tiny dimensions of tens of nanometers, or millimeters of a millimeter).
One might be able to establish a hybrid discipline, plasmonics, in which light is first converted into plasmons, which then propagate in a metallic surface but with a wavelength smaller than the original light; the plasmons could then be processed with their own two-dimensional optical components (mirrors, waveguides, lenses, etc.), and later plasmons could be turned back into light or into electric signals.

To show how this field is shaping up, here are a few plasmon results from the APS March Meeting:

1. Plasmons in biosensors and cancer therapy: Naomi Halas described how plasmons excited in the surface of tiny gold-coated, rice-grain-shaped particles can act as powerful localizers of light for doing spectroscopy on nearby bio-molecules. The plasmons’ electric fields at the center of the rice are much more intense than those of the laser light used to excite the plasmons, and this greatly improves the speed and accuracy of the spectroscopy. Tuned a different way, plasmons on nanoparticles can be used not just for identifying individual molecules, but for the eradication of cancer cells in rats.

2. Plasmon microscope: Igor Smolyaninov reported that he and his colleagues were able to image tiny objects lying in a plane with spatial resolution much better than diffraction would normally allow; furthermore, this far-field microscopy—the light source doesn’t have to be on the same side of the object as the detector—allowed them to measure wavelengths smaller than the original light; the plasmons could then be processed with their own two-dimensional wave guides.

3. Photon-polariton superlensing and giant transmission: Gennady Shvets reported on his use of surface phonons excited by light to achieve super-lenses (lensing with flat-panel materials) with microscope resolutions as good as one-thousandth of a wavelength in the mid-infrared range of light. He and his colleagues could image subsurface features in a sample, and they observed what they call “giant transmission,” in which light falls on a surface covered with holes much smaller than the wavelength of the light. Even though the total area of the holes is only 6 percent of the total surface area, 30 percent of the light got through, courtesy of the plasmon activity at the holes.

Future plasmon circuits at optical frequencies:

A New Kind of Acoustic Laser

Sound amplification by stimulated emission of radiation, or Saser, is the acoustic analog of a laser. Instead of a feedback-built potent wave of electromagnetic radiation, a saser would deliver a potent ultrasonic wave.

The concept has been around since the 1970s and several labs have implemented models with differing features. In a new version, undertaken by scientists at the University of Nottingham in the U.K. and the Lashkarave Semiconductor Institute in Physics in Ukraine, the saser can be used to amplify ultrasonic waves. The amplification takes place—consists of stacks (or a superlattice) of thin layers of semiconductors which together form “quantum wells.”

In these wells, really just carefully confined planar regions, electrons can be excited by parcels of ultrasound, which typically possess millielectronvolts of energy, equivalent to a frequency of 0.1-1 terahertz. Just as coherent light can build up in a laser by the concerted, stimulated emission of light from a lot of atoms, in a saser coherent sound can build up by the concerted emission of phonons from a lot of quantum wells in the superlattice.

In lasers the light build-up is maintained by a reflective optical cavity. In the U.K.-Ukraine saser, the acoustic build-up is maintained by an artful spacing of the lattice layer thicknesses, as is the case with a laser. Eventually the sound wave emerges from the device at a narrow angular range, as do laser pulses. The monochromatic nature of the acoustic emission, however, has not yet been fully probed. The researchers believe their saser is the first to reach the terahertz frequency range using phonons.

A Hint of Negative Electrical Resistance

A hint of negative electrical resistance emerges from a new experiment in which microwaves of two different frequencies are directed at a 2-dimensional electron gas. The electrons, moving at the interface between two semiconductor crystals, are subjected to an electric field that induces damped oscillatory motion (longitudinal) and a fixed magnetic field in the direction perpendicular to the plane. In such conditions the electrons execute closed-loop trajectories which will, in addition, drift forward depending on the strength of the applied voltage.

A few years ago, two experimental groups observed that when, furthermore, the electrons were exposed to microwaves, the overall longitudinal resistance could vary widely—for example, increasing by an order of magnitude or extending down to zero, forming a zero-resistance state, depending on the relation between microwave frequency and the strength of the applied magnetic field. Some theorists proposed that in such zero-resistance states, the resistance would actually be less than zero: the swirling electrons would have drifted backwards against the applied field, a phenomenon which, backwards motion would be difficult to observe because of an instability in the current flow.

A Utah/Minnesota/Rice/Bell Labs group has now tested this hypothesis in a clever bichromatic experiment using microwaves at the two frequencies. Michael Zudov and Richard Du sent microwaves of two different frequencies at the electrons, observing for nonzero-resistance states the resultant resistance was the average of the values corresponding to the two frequencies separately. On the other hand, when the measurements included frequencies that had yielded a zero resistance, the researchers observed a dramatic reduction of the signal.

Judging from the average resistance observed for non-zero measurements, they deduce that whenever zero resistance was detected, the true zero-resistance had actually been less than zero. (Zudov et al., Phys. Rev. Lett. 96, 236804, 2006)

Particle Acceleration by Stimulated Emission of Radiation—PASER for Short

Particle Acceleration by Stimulated Emission of Radiation (PASER for short), a sort of parallel-development of the laser process, has been demonstrated, for the first time, by a team of physicists from the Technion-Israel Institute of Technology using the accelerator facilities at the Brookhaven National Lab.

In a regular laser, photons traveling through an active medium (a body of excited atoms) will stimulate the atoms, through collisions, to surrender their energy in the form of additional
tional emitted photons; this coherent process builds itself on until a large pulse of intense light exits the cavity in which the amplification takes place. In the new proof-of-principle PASER experiment, the active medium consists of a CO2 vapor, and instead of surrendering the energy in the form of stimulated photons, the atoms transfer their energy to a beam of electrons.

The electrons stimulate the atoms into giving up their surplus energy through colli-
sions. The electrons’ energy is amplified in a coherent way. Although millions of collisions are involved for each electron, no heat is gen-
erated. The transferred energy goes into an enhanced electron motion. One could say that here was a laser which produced no laser light, only a laser-like transfer of energy resulting in electron accel-
eration. It should be said that the electrons began with an energy of 45 million electron volts (MeV) and absorbed only a modest energy of about 200 thousand electron volts (keV).

Being able to accelerate electrons with energy stored in individual atoms/molecules, a potential new application of the PASER, provides new opportunities since the acceler-
eted electrons may prove to be significantly “cooler” (they are more collimated in veloc-
ty) than in some other prospective acceleration schemes, enabling in turn the secondary
generation of high-quality X-rays, which are an essential tool in nano-science. (Banna,

Hypersound

Hypersound, acoustic pulsation at 200 gigahertz frequencies, has been produced in the same kind of resonant multilayered semiconductor cavity as used for electronics. Physicists
at the Institut des Sciences de Paris (France) and the Centro Atómico Bariloche and
Instituto Balseiro (Argentina) generate the high frequency sound pulses in a solid materi-
al made of thin gallium arsenide and aluminum arsenide layers. One can picture the sound, excited by a femtosecond laser, as being a short pulse of wave energy equally particle-
like phonons, excitations pulsing through the stack of layers. These phonons are reflected at either end of the device, called a nanocavity, by further layers with a much different acoustic impedance of acting as mirrors. Acoustic impedance is the acoustic analog of the refractive
index for light.

Bernard Jusserand says that he and his colleagues hope to reach the terahertz acoustic
range. The wavelength for such “sound” is only nanometers in length. They believe that a new
cell, nanoelectronics, has been inaugurated, and that the acoustic properties of semi-
conductor nanodevices will become more prominent. THz phonons, and more specifica-
 tally the reported nanocavities could, for example, be used to modulate the flow of charges or light at high frequency and in small spaces. THz sound might also participate in the develop-
ment of “acoustic lasers” or in novel forms of tomography for imaging the inte-

First Antimatter Chemistry

The Athina collaboration, an experimental group working at the CERN laboratory in
Geneva, has measured chemical reactions involving antiprotonic hydrogen, a bound
object consisting of a antiproton paired with a proton.

This composite object, which can also be called protium, eventually anni-
hilates itself, leaving an even number of telltale charged pions. Normally the annihilation comes about in a tri-
llionth of a second, but in the Athina experimen-
tum the duration is a whopping millionth of a second.

The protonium comes about in the fol-
lowing way. First, antiprotons are created in a
CERN experiment and then beamed into a target,
bring the antiprotons to a point where they can
be caught in Athina’s electrostatic trap. This allows
the researchers to study them, for the first time, a chemical reaction between the simplest antimat-
terion— the antiprotons— and the simplest matter molecular ion, namely H₂⁻ (two hydro-
gen atoms with one electron missing). Joining these two ions results in the protonium plus
antiprotons into a thin target. The resultant
antiprotons then undergo the deceleration, from
97 percent down to 10 percent of the speed of light. Several more stages of cooling
were observed. After sending 2 x 10¹⁹ calcium projectiles into the target, one atom of ele-
ment 118 was discovered in the year 2002 and two more atoms in 2005. The researchers
held up publication after seeing their first specimen in order to find more events. According
to Livermore physicist Ken Moody, the three events have been well studied and the odds
of a statistical fluke working here are less than a part in 100 thousand.

Caution would naturally be on the minds of anyone announcing a new element. Evidence
for element 118 was offered once before, by a team at the Lawrence Berkeley National
Laboratory in 1995, but this claim was later retracted when it was discovered that some of the
data had been falsified.

In searching through 10ⁱ⁷ collision events, how do you know you have found a new ele-
ment? Because of the clear and unique decay sequence involving the unloading of alpha
particles. In this case, nuclei of element 118 decay to become element 116 (hereby itself
discovered for the first time), and then element 114, and then element 112 by emitting
detectable alphas. The 112 nucleus subsequently fissions into roughly equal-sized daugh-
ter particles.

The average lifetime observed for the three examples of element 118 was about one mil-
isecond, not long enough to perform any kind of chemical tests. Element 118 lies just beneath
radon in the periodic table and is therefore a kind of noble gas.

The information about element 118 was published in Nature and a discovery of elements 113 and
115 and next hope to produce element 120 by crashing a beam of iron atoms into a pluton-

New Baryons Discovered

The periodic table of baryons has now been supplemented with several heavyweight mem-
bers. The new members of the baryonic periodic table are unstable and ephemeral, but their
observed existence serves to expand our understanding of matter in the universe. The
new baryons, the heaviest yet with masses around 5.8 gigaelectron
volts, were sifted from trillions
of proton-antiproton collisions con-
ducted at an energy of 2 tera
volts at the Fermilab.

Up to now there was only one
well established bottom-quark-
bearing baryon, the so called
Lambda. The first evidence for its existence was reported by CERN and Fermilab in late
1990s based on a handful of events. Now the CDF collabora-
tion at Fermilab is claiming dis-
covery of two baryon types, each
on the basis of about 100 events. Actually there are four new so-called Sigma_b, baryons
two positively charged baryons with a u-b-u combination (one with spin 1/2, one with spin 3/2), the first of which constitutes a sort of bottom-proton, and two negatively charged baryons
with a u-d-b combination (one with spin 1/2 and one with spin 3/2). In all cases, the Sigma_b
are so heavy that they decay almost immediately into a Lambda_b particle (with a u-d-b set of quarks) plus a pion. In the detector the Lambda_b typically flies about 100 microns before decaying into Lambda_b (a
Lambda_b baryon with a c quark instead of a b), which quickly decays into an ordinary pro-
ton.

The new results were announced at a talk at Fermilab by Petr Maksimovic, of Johns
Hopkins University. Jacobo Konigsberg, of the University of Florida, the co-spokesperson
for the CDF group says that the statistical odds against the Sigma_b particles being real are
at the level of a few parts in 10¹⁵. (For more information see Fermilab press release:

Have Particle Masses Changed since the Early Universe?

Indications of a change in the proton-to-electron mass ratio have shown up in compar-
sions of the spectra of hydrogen gas as recorded in a lab with spectra of light coming from
hydrogen clouds at the distance of quasars. This is another of those tests of so-called phys-
ic constants that has a frustratingly absolute constant.

The proton-to-electron mass ratio (denoted by the letter μ) figures in setting the scale of the
strong nuclear force.

There is at present no explanation why the proton’s mass should be 1,836 times that of
the electron. The new search for a varying μ was carried out by Weim Ubachs of the Vrije
Universiteit Amsterdam. He and his colleagues studied hydrogen gas in the lab, perform-
ing ultra-high-resolution spectroscopy in the difficult-to-access extreme-ultraviolet range.
This data is compared to accurate observations of absorption spectra of distant hydrogen
clouds, which themselves are composed of even more distant quasars) as recorded with the European
Southern Observatory (ESO) in Chile.

The astronomical hydrogen is essentially hydrogen as it was 12 billion years ago, so one can
make measurements of a constant of μ for mu. The position of a particular spectral line depends
on the value of μ, locate the spectral line accurately and you can infer a value for μ. In this
way, the researchers report that they see evidence that μ has decreased by 0.002 per-
to those 12 billion years ago. According to Ubachs, the statistical confidence of his spec-
tral measurements was at the level of 3.5 standard deviations. (Reinhold et al., Phys. Rev.
Lett. 96, 151101, 2006)

A Baby Picture That’s Worth a Nobel Prize

The 2006 Nobel Prize for Physics was awarded to John Mather of NASA/Goddard Space
Flight Center and Michael J. Turner of the University of Chicago, Berkeley and Lawrence
Berkeley National Laboratory. They are cited for the study of the early universe. They
were instrumental in developing the Cosmic Background Explorer (COBE) experiment. This
orbiting experiment was set up to detect faint temperature variations in the cosmic microwave
background (CMB), the bath of radiation representing the first light able to move freely
across the universe. The CMB is a baby snapshot of the universe when it was less than 300,000
years old, and the radiation has cooled to about 2°C.

In 1992, Mather and Turner, working with George Smoot of the University of California,
Berkeley, and Charles Steer of the National Aeronautics and Space Administration,
recorded the first direct measurements of the CMB. Mather and Turner received the Nobel
Prize for Physics “for their pioneering contributions to the discovery of the cosmic
microwave background radiation,” which included the discovery of the CMB’s anisotropy –
a pattern in the temperature variations of the CMB, which can be used to infer the history of
the universe. The CMB data showed that the universe is flat and that the total energy density
in the universe is 3%.

The CMB’s discovery was a triumph of the Big Bang theory, which describes the early
universe as a hot, dense fireball that expanded exponentially and cooled to form the
modern universe. The CMB’s discovery confirmed the Big Bang theory and provided strong
evidence for the existence of dark matter and dark energy.

The CMB is a baby picture of the universe, and the Nobel Prize recognizes Mather and
Turner’s pioneering contributions to the discovery of the CMB and its implications for the
evolution of the universe. Their work was instrumental in shaping our understanding of the
early universe and its role in the larger context of cosmic evolution. 
atoms formed. But how big those clumps of matter were, showing up as slight temperature variations in the map of the CMB across the sky, was unknown.

At a press conference at the American Physical Society April meeting in 1992, COBE speaker John Mather and Nobel laureate George Smoot announced the second-order results. The first was the first to measure the variations and the first to provide a really precise average temperature for the universe, 2.726 degrees Kelvin. The COBE work represented a feat of great experimental science since the faint variations in the temperature of the distant CMB had to be measured against a foreground cloud of microwave radiation coming from our solar system, our galaxy, and other celestial objects.

Later CMB detectors, including the balloon-borne Boomerang and the land-based Degree Angular Scale Interferometer (DASI), added more and more detail to the microwave background. The most recent and best microwave measurements have been presented by the DASI detector, which provides the clearest multipole curve yet as well as supplying the best values for the physics of the universe at the age of the universe and the overall curvature of space, and the time when the first atoms formed and the first stars formed.

**Attack of the Teleclones**

Should quantum cryptographers begin to worry? In contrast with everyday matter, quantized objects such as photons cannot be copied, at least not perfectly, according to the "cloning theorem." Nonetheless, imperfect cloning is permitted, so long as Heisenberg's Uncertainty Principle remains inviolate.

Now, quantum cloning has been combined with quantum teleportation in the first full experimental demonstration of "telecloning" by scientists at the University of Tokyo, the Japan Science and Technology Agency, and the University of York. In ideal teleportation, the original is destroyed and its exact properties are transmitted to a second, remote particle; the Heisenberg principle does not apply because no definitive measurements were made on the original particle. In telecloning, the original is destroyed, and its properties are sent not to one but two remote particles, with the original's properties reconstructed to a maximum accuracy (fidelity) of less than 100 percent.

In addition to representing a new quantum-information tool, telecloning may have an exotic application: tapping quantum cryptographic channels. Quantum cryptographic protocols are so secure that they may discover tapping. Nonetheless, with telecloning, the identity and location of the eavesdropper could be guaranteed uncompromised. (Koike et al., Phys. Rev. Lett. 96, 060504, 2006)

**Slow-Motion Boiling**

A new study, carried out at a chilly temperature of 33 degrees Kelvin, explains why certain industrial heat exchangers (including those used at power plants) melt catastrophically when steam formation undergoes a process referred to as a "boiling crisis." Boiling, a sort of accelerated evaporation, is usually a very efficient form of energy transfer because of the transport of latent heat (the heat required for a substance to change its phase); energy transfer from a stream of liquid to a layer of the formation of vapor bubbles. This can be an important hitch in this process, however, and that is the poorly understood boiling crisis.

This potentially dangerous situation comes about as follows: at high enough temperatures the formation of bubbles becomes so great that the entire surface of the heating element will be covered, forming a vapor blanket which insulates the liquid above from absorbing heat. (Just as a water droplet, hitting a frying pan, evaporates only very slowly.) The result is a buildup of heat in the heater and possible boiling of the liquid.

What Vadim Nikolayev and his colleagues at the Ecole Superieure de Physique et de Chimie Industrielles in Paris, Comission of Atomic Energy in Grenoble, and the University of Bordeaux have done is to provide the first detailed look at the boiling crisis by performing simulations and laboratory tests of a theory which suggests that the overheating comes about because of vapor recoil. That is, at high enough heat flux, the growing bubble will forcefully push aside liquid near the heating element, expanding the potentially dangerous insulating vapor layer.

This was upheaved by experimental work performed not at the blazing temperature of high-pressure steam but near the chilly critical temperature of liquid hydrogen, where boiling would occur very slowly, in a way that could be glimpsed more completely. Thanks to the universality of fluid dynamics, however, lessons learned at 33 degrees Kelvin should be applicable to higher temperatures.

Nikolayev believes that better understanding of the boiling crisis will facilitate certain counterrude measures. This is important since possible boiling problems occur not just at major industrial heat exchangers but also at the micro- and nanoscale. He notes that the nascent field of "bionanotechnology"--the science of biological systems at intercellular, cellular, and subcellular levels--will require a better understanding of heat transport in very small channels.

According to Tino, unlike gravity-measuring experiments which use torsional balances or camlivers, the Florence approach measures gravity directly and over shorter distances. The atom-trap setup should also prove useful for future inertial guidance systems and optical clocks. (Ferrari et al., Phys. Rev. Lett. 97, 060402, 2006)

**Ellipsoidal Universe**

A new theoretical assessment of data taken by the Wilkinson Microwave Anisotropy Probe (WMAP) suggests that the universe–at least that part of it that can be observed–is not spherically symmetric, but more like an ellipsoid.

The WMAP data has served to nail down some of the most important parameters in all of science. One remaining oddity about the WMAP results, however, concerns the way in which portions of the sky contribute to the overall map of cosmic microwaves; samples of the sky smaller than one degree across, or at the degree level, or tens of degrees seem to be contributing radiation at expected levels. Only the largest possible scale, that on the order of the whole sky itself (the technical term is quadrupole moment), seems to be under-represented.

Now Leonardo Campanelli of the University of Ferrara and his colleagues Paolo Cea and Luigi Tedesco at the University of Bari (all in Italy) have studied what happens if the quadrupole anomaly if one supposes that the shell from which the cosmic microwaves come toward earth is an ellipsoid and not a sphere. This shell is called surface of last scattering since it corresponds to that moment in history when photons largely stopped scattering from charged particles when it became cool enough for many of the particles to bundle themselves into neutral atoms. If the microwave shell is an ellipsoid with an eccentricity of about 1 percent, then the WMAP quadrupole is exactly what it should be.

This is not the first time a non-spherical universe has been suggested, but it is the first time the idea has been taken seriously in the WMAP data. What we need is more data to see if the quadrupole effect is significant or not.

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**Atoms in a Trap Measure Gravity at the Micron Level**

Nowadays many of the most sensitive measurements in science depend on some quantum phenomenon which very subtly can often be exploited to gain maximum precision. In an experiment conducted at the Universidad de Finns Universitat de Barcelona, a research team led byProfessor James Gillies has taken a step toward finding such a quantum gravitational effect; in doing so, they have demonstrated the first full-scale implementation of a true gravitational "teleportation" experiment; what happens is that the electrons do not all move in the direction of the force, but instead oscillate back and forth in place.

In a new experiment conducted by Guglielmo Tino and his Florence colleagues, the particles interact not with a single atom but with an atomic cluster, the scientists use the "Pascal's triangle" effect of cold, ultra-pure atoms to trap and measure the gravity of the nearby Earth.

"In this case, we have a quantum gravitational effect which could be exploited not just in fundamental physics, but also in many applications, such as allowing nerve cells to communicate."

According to Tino, unlike gravity-measuring experiments which use torsional balances or camlivers, the Florence approach measures gravity directly and over shorter distances. The atom-trap setup should also prove useful for future inertial guidance systems and optical clocks. (Ferrari et al., Phys. Rev. Lett. 97, 060402, 2006)

**GeV Acceleration in Only 3 Centimeters**

Much of particle physics over the past century was made possible by machines that could accelerate particles up to energies of thousands of electronvolts (keV), then millions of electronvolts (MeV), and then billions (GeV). Possessing such high energies, beam particles can, when they smash into something, recreate for a short time a small piece of the early hot universe. But how to transport these particles over long distances to take a substantial step forward. Physicists at the Lawrence Berkeley National Laboratory and the University of Oxford have accelerated electrons up to an energy of 1 GeV in a space of only 3 centimeters. The device used is called a laser wakefield accelerator since it boosts the electrons using potent electric fields set up at the trailing edge of a burst of laser light traveling through a plasma-filled cavity. Previously, gradients as high as 100 GeV per meter had been attained, but the acceleration process could not be sustained to energies much above 200 MeV (Leemans et al., Nature Physics, October 2006)

**Nanopores and Single-Molecule Biophysics**

Some proteins naturally form nanometer-scale pores that serve as channels for useful biochemical ions. Through this ionic communication, nanochannels enable many functions in cells, such as allowing nerve cells to communicate.

Nanopores can be destructive, too. When the proteins of bacteria and viruses attack a cell, their nanopores can facilitate infection, for example by shooting viral DNA through them into the cell.

At the APS March Meeting in Baltimore, John J. Kasianowicz (National Institute of Standards and Technology) showed how single biological nanopores can be used to detect and characterize individual molecules of RNA and DNA. He also demonstrated constructive uses for micro-sized nanopores in diagnosing anthrax infections and testing for biowarfare drugs.

Anthrax bacteria secrete a protein called "protective antigen" that attaches to an organic membrane such as a cell wall. The protein forms a nanopore that penetrates the membrane. When another anthrax protein, called "lethal factor," attaches to the protective antigen molecule, it prevents ionic current from flowing through the pore and out of the organic membrane.

By monitoring animal blood samples for changes in ionic current, Kasianowicz and his colleagues at the National Cancer Institute and the United States Army Medical Research Institute of Infectious Diseases have electronically detected a complex of two anthrax proteins in less than an hour, as opposed to the existing methods which can take up to days. Kasianowicz has also recently developed a method for measuring potential therapeutic agents against anthrax toxins using a nanopore device.

A Brown University group led by Sean Ling was among those reporting progress in developing a nanopore-based method for sequencing DNA faster and more cheaply than traditional biochemical techniques. In one scenario, the change in ion current as DNA moves through a nanopore is recorded, and the device is able to distinguish between different DNA sequences. This is a potential breakthrough in the field of genomics.

Now, quantum cloning has been combined with quantum teleportation in the first full experimental demonstration of "telecloning" by scientists at the University of Tokyo, the Japan Science and Technology Agency, and the University of York. In ideal teleportation, the original is destroyed and its exact properties are transmitted to a second, remote particle; the Heisenberg principle does not apply because no definitive measurements were made on the original particle. In telecloning, the original is destroyed, and its properties are sent not to one but two remote particles, with the original's properties reconstructed to a maximum accuracy (fidelity) of less than 100 percent.

In addition to representing a new quantum-information tool, telecloning may have an exotic application: tapping quantum cryptographic channels. Quantum cryptographic protocols are so secure that they may discover tapping. Nonetheless, with telecloning, the identity and location of the eavesdropper could be guaranteed uncompromised. (Koike et al., Phys. Rev. Lett. 96, 060504, 2006)
ies. Discussing his group’s latest work with artificial, silicon-based nanopores, Cees Dekker of the Delft University of Technology in Delft, Holland showed how lasers and other manipulations with the artificial pores are enabling new single-molecule biophysics studies on the properties of DNA, RNA, and proteins by studying how they pass through the pores.

Dune Tunes

For centuries, world travelers have known about sand dunes that issue loud sounds, sometimes of great tonal quality. Now, a team led by Thomas Hertog of the Delft University of Technology in Delft, Holland showed how lasers and other manipulations near the surface of the universe is that a substance, dark energy, fills the vacuum and produces a uniform repulsive force between any two points in space. Quantum field theory allows for the existence of such a uniform repulsive force. Unfortunately, its prediction for the value the cosmological constant is some 120 orders of magnitude larger than the observed value.

In 2003, cosmologist Andrei Linde of Stanford University and his collaborators showed that string theory allows for the existence of dark energy, but without specifying the value of the cosmological constant. String theory, they found, produces a mathematical graph shaped like a mountainous landscape, where altitude represents the value of the cosmological constant. After the big bang, the value would settle on a low point somewhere between the peaks and valleys of the landscape. But there could be on the order of 10^120 possible low points and no obvious reason for the universe to pick the one we observe in nature.

Some experts hailed this multiplicity of values as a virtue of the theory. But critics see the landscape as exemplifying the theory’s inability to make useful predictions.

The Hawking-Hertog approach is meant to address this concern. It looks at the universe as a quantum system in the framework of string theory. In Richard Feynman’s formulation of quantum theory, the probability that a photon ends up at a particular spot is calculated by summing up over all possible trajectories for the photon. Hawking and Hertog argue that the universe itself must also have different trajectories at once, evolving through many simultaneous, parallel histories, or “branches.”

But applying quantum theory to the entire universe is tricky. Here you have no control over the initial conditions, nor can you repeat the experiment again and again for statistical significance. Instead, the Hawking-Hertog approach starts with the present and uses what we know about the branch of the universe to trace its history backwards. Again, there will be multiple possible branches in our past, but most can be ignored in the Feynman summation because they are just too distant from the universe we know.

For example, Hertog says, knowledge of our universe is very close to being flat that allow one to concentrate on a very small portion of the string theory landscape whose values for the cosmological constant are compatible with that flatness. That could in turn lead in predictions that are experimentally testable. For example, one could calculate which universes our universe is likely to produce the microwave background spectrum we actually observe. (S. W. Hawking and Thomas Hertog Phys. Rev. D 73, 123527, 2006)

Testing Special Relativity and Newtonian Gravity

Lorentz invariance says that the laws of physics are the same for the observer on earth or one who is rotated through space or traveling at a constant speed relative to the observer at rest. Some researchers are looking for a crack in the universe in the form of a very faint form of energy, which would be consistent with a violation of Lorentz invariance. A new experiment conducted at the University of Washington, in Seattle, has sought such an anomalous field and not found it even at an energy scale of 10^-23 eV/Hz.

This is the most stringent search yet—by a factor of 100—for Lorentz-invariance breaking in the effective potential.

The Washington work, described at the APS April Meeting in Dallas by Claire Cramer, is part of an ongoing battery of tests carried out with a flexible and sophisticated torsion-balance experiment. In this case, a pendulum is made of blocks of wood from both the orbital motion of an electron around its nucleus and from the intrinsic spin of the electron itself. Carefully choosing and arranging the blocks, one can create an assembly that has zero magnetization and yet still have an overall nonzero electron spin. The existence of a preferred direction, in this case, is violating spin-related force would have to be in terms of the pendulum. The conclusion: any such quasi-magnetic field would have to be weaker than about a femtogauss, or 10^-15 gauss.

Atom Wires

Physicists have built the world's thinnest gold necklaces, at just one atom wide. Paul Snijders and Sven Rogge from the Kavli Institute of Nanoscience at the Delft University of Technology, in Delft, Holland, and Hanno Weitering from the University of Tennessee build Physicists have built the world's thinnest gold necklaces, at just one atom wide.

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en the surface of the stars. Such a surface, says Los Alamos scientist Andrew Steiner, can be compared to a liquid surface. On Earth, liquid surfaces are generally flat. Because of surface tension, molecules in a liquid are forced to stay close to one another. A liquid surface is the result of the tension in the surface forces between molecules above the surface. At a quark star, by contrast, surface tension may not be large and the crust of the star could form extra surfaces, nugget-like objects without any undue energy cost. The positively charged quark loops would be surrounded by a sea of electrons, as required to make the quark electrically neutral.

What would be the test of the hypothesis of an inhomogeneous termination at a quark-star surface? Again, the Los Alamos group is at odds with the prevailing model, which says quark stars would be more luminous the further they beg a way from the core. The hypothesis would be coherent light resembling the radiation issuing from a laser; but the mechanism of light production would not be stimulated emission, as it is in a laser, but rather the concerted movement of quark layers at the crust.

The passing shock front, set in motion by a projectile or laser blast, successively excites a huge density wave in the crystal, the atoms, returning to their original places in the matrix, emit light coherently, mostly in the Terahertz wavelength band. Although sources of coherent light in this part of the electromagnetic spectrum have developed in recent years, it is still a difficult task.

The next step will be to carry out an experimental test of the shock-wave light production. According to Evan Reed, the first likely application of coherent radiation will be as a diagnostic for understanding shock waves. The radiation would provide light through craters.
H. Frederick Dylla Succeeds Marc Brodsky as Head of the American Institute of Physics

H. Frederick Dylla has been selected to be the next Executive Director and CEO of the American Institute of Physics. AIP is an organization made up of ten member societies, including APS.

Dylla will start working at AIP on the day after Marc H. Brodsky, who will retire on March 31 after more than 13 years at AIP’s helm. Dylla will assume the role of Chief Executive Officer and Executive Director on the following day, April 1, 2007.

“The Fred has already been an inspiration to a number of the AIP family,” says APS Governing Board Chair M. I. Millard. “His ideas and initiatives have enhanced AIP and its Member Societies for many years. As the next CEO and Executive Director, his experience, enthusiasm, and outward-looking nature will drive AIP in the right direction as we work with the rest of the scientific community to confront a future filled with challenges.”

“Having interacted with Fred over many years,” says APS Executive Officer Judy Franz, “I can attest to his ability and judgment. I look forward to working closely with him in his new position.”

“I’m honored to be selected to be the next AIP Executive Director,” says Dylla. “I am very optimistic for the outlook of the Institute to continue to grow in its role of supporting the value of physics for its Member Societies, the physics community and the world at large. I look forward to working with the Member Societies to continue to provide first-rate services and to collaborate on joint activities.”

Dylla has been with the U.S. Department of Energy’s Thomas Jefferson National Accelerator Facility (Jefferson Lab) in Newport News, Virginia since 1990. During this time, he has concurrently held an Adjunct Professorship in Physics and Applied Science at the College of William and Mary. He received his B.S., M.S. and Ph.D. in physics from the Massachusetts Institute of Technology.

Holding a career-long interest in science education, Dylla helped to found and lead body of education programs at Jefferson Lab. He founded similar programs at Princeton University’s Plasma Physics Laboratory, where he held various research and management positions from 1975 to 1990. While at Princeton, he helped develop technology for nuclear fusion reactors, plasma accelerators, and materials processing.

At Jefferson Lab, Dylla served as the Chief Technology Officer and as Associate Director for the Free-Electron Laser (FEL) program. Dylla served on the AIP’s Governing Board in the early 1990s and rejoined the Board in 2004. He is a Fellow of the American Physical Society. He is a founding member of the Forum of Industrial and Applied Physics, currently the largest unit of the APS.

Outgoing CEO and Executive Director Marc Brodsky will have served AIP for thirteen and a half years when he retires at the end of March 2007. “I am pleased that AIP will be in such good hands,” says Brodsky. “Fred brings invaluable managerial experience to AIP and his stature in the physics community instills confidence that AIP will continue to serve its broad constituencies well.”

During his tenure, Brodsky oversaw dramatic changes in AIP publishing and publishing services, as nearly all editorial, production, distribution and business processes were changed to deal with electronic publishing. All the journals and magazines AIP publishes for itself and others went onto the World Wide Web, increasing access to the physics literature to more people than ever before in history. AIP outreach programs and services expanded its information offerings for the general public to the Web and many other outlets, including regular science news segments to over 50 million nightly viewers of local TV news programs. He also actively defended AIP’s freedom of the press rights on many fronts, including attempted government restrictions on the processing of manuscripts from certain countries and suits from some who tried to restrict knowledge gained from comparisons of journal prices.

He keeps careful records of his own wins and losses, and insists he’s never had a losing year as a poker player. In fact, he has earned the majority of his income since 2002 from poker.

Binger’s strong showing at the WSOP gives him a healthy bankroll to play a few more big tournaments, but he hasn’t given up on physics entirely. He still has an office at SLAC, and eventually hopes to find a balance between physics research and poker. Ideally, he would like to do well enough at amassing poker winnings to continue his theoretical research without having to scrounge for grant money. Then again, he could write his own book on poker strategy, or perhaps follow in the footsteps of poker champion Phil Gordon by hosting Celebrity Poker Showdown.

In the future he could quite literally be in the cards.

Announcements

American Institute of Physics Prize for Industrial Applications of Physics, 2007-2008

Awarded on behalf of the Corporate Associates of the American Institute of Physics

Sponsored by the General Motors Corporation and AIP Corporate Associates

Purpose

To recognize outstanding contributions by an individual or individuals to the industrial applications of physics.

The Award

The prize consists of $10,000, an allowance for travel to receive the prize, and a certificate citing the contributions made by the recipient(s).

For more information see: www.aip.org/ca/lapri.html

Nominations must be postmarked by May 1, 2007.

Conference on Communicating Science to a Broader Audience

April 12-13 2007 University of Nebraska, Lincoln

Plenary Speakers: Curt Supplee (NSF); Sidney Perkowitz (Emory University)

Panelist Include: David Ehrenstein (PR Focus); Sean Carroll (Caltech); Jennifer Ouellette (author and editor); Tim Gay (University of Nebraska)

Registration Deadline: March 1, 2007

For the full program and more information: http://physics-new.unl.edu/~diandra/communicatingscience/

Correction

The image of a waffle on page 6 of the December APS News in an article about the 2006 Division of Plasma Physics meeting appeared without attribution. The waffle image was done by a collaboration between the University of Texas at Austin and the University of Michigan, and was the subject of a tutorial session at the meeting. We thank Michael Downer of the University of Texas for pointing out our omission.

Physicist continued from page 3

The odds of it happening twice in a row at 70 to 1. Still, he was philosophical about the loss, figuring he’d got ten had his luck out of the way.

Not that he’s superstitious, mind you: “Your runs of luck will generally not be out of bounds with what the probability statistics say,” he insists. According to Binger, luck only reaps in the short term. Over the long term, the percentages hold sway.

Heidi Kallman and P. Palmieri

The field of x-ray astronomy has evolved rapidly in recent years. This has been driven by advances both in observational data of high statistical quality and spectral resolution from x-ray astronomy satellites and in the understanding of the astrophysical implications of x-ray spectra associated with planets, comets, and other primarily neutral or solid objects. This review covers extensively as well atomic data from cosmic sources driven by electron ionization and photoionization as their applications to x-ray astronomy.

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program, and scientific communities outside of the fusion community, because it is applicable to large-scale international collaboration in general. Clearly, the ITER Agreement starts out with a purpose statement specifically directed at ITER, but virtually every other provision deals with how the Parties will interact with each other and the Director General as the project evolves. The ITER Agreement addresses issues such as governance, resources, and intellectual property rights, rather than plasma confinement, heating and diagnostics. These negotiations, recently formally concluded, involved the Technical Coordinating Body (TCB) and the US and foreign (State for US) ministers of each of the Parties, including specialists from many sectors. As a participant in these negotiations, privy to the many individual discussions and considerable time and human resources required that led to consensus on a myriad of difficult points, I believe it highly unlikely that any person or Party would seriously entertain trying to redo these compromises for the next large project. Therefore, I believe that the ITER Agreement, once signed and entered into force, should be a most useful document with lasting value as it will represent a foundational document of international agreements on how to work together. This would then be available for use with only minor changes for future large-scale international scientific collaboration. I appreciate the opportunities given to me by my former employers, ORNL and DOE, and all my colleagues, at home and abroad, to participate in and contribute to these unparalleled international collaborations and our welcome the next generations of researchers to build on these foundations of hard-won trust, continuity of service, and crucial support at highest political levels around the world.

Michael Roberts, recently retired from the Office of Fusion Energy Sciences, within the DOE Office of Science, was responsible for US international fusion programs from February 1979 through April 2006; he joined the ORNL Fusion Program in 1946. He has served as Chair of the IEA Fusion Power Coordinating Committee and as Chair of the ITER Contact Persons. The views in this note are his alone and do not purport to represent those of the US DOE.
instituted an open access initiative

12 February• 2007

Access is a controversial idea, and not without funding body, etc.). The Directory of Open Access Journals physicists. run by Cornell University, is the principal means of transfer of a database of journal policies regarding pre/post-print archiving. archives which comply with the requirements of OA policies. Archives which are interoperative and can be searched as though they comprised a single virtual database, using services such as OAster. There are many models of open-source software packages available for building and maintaining OA-compliant archives. Peter Suber maintains a list of lists of such archives, and SHERPA maintains a database of journal policies regarding pre/post-print archiving. Among the hundreds of universities and research institutions are building their own. PubMed Central, maintained by the NIH, is probably the most prominent example of such a service within the sciences. A journal submitted for publication at Cornell University, is the principal means of transfer of research results for many (if not most) mathematicians and physicists. OA journals are in most respects the same sorts of entities as traditional paid-access journals, but without the access fees. They perform peer review, and make the refereed articles available free to all comers. They pay the bills in a number of different ways. About half charge author-side fees, though who exactly pays these is variable (author, author’s institution, funder, journal). The OA journal archive at Cornell University (arXiv.org) currently lists nearly 2,500 peer-reviewed OA journals. Three of the most prominent OA journal publishers are the Public Library of Science, Hindawi Publishing and BioMed Central, and a number of traditional publishing companies now offer OA options.

A Personal Example: More than half of my publications to date have been OA journals, either before or on a development process where they were ultimately OA journals. You cannot read them without paying a fee or relying on a library which carries (and has therefore paid for) the journal. I am not alone in my practice, and I hope that others will follow as well. Why do I do this? Because OA offers significant benefits and advantages to a variety of stakeholders: authors, readers, and publishers. The OA journal archive at Cornell University (arXiv.org) contains more than 30,000 papers. There are 39,136 papers in PubMed on P53. There are many times a given paper has been cited by other researchers in their published work? This idea led to the development of the Open Access impact factor, a measure of a particular journal’s importance within its own field. These sorts of bibliometric indicators are relied upon heavily by science administrators making decisions about funding, tenure, and so on. Open access, by removing the barriers that prevent research literature from being accessible to anyone, makes that knowledge more available and useful to researchers, scientists, and the general public.

Advantages for authors: There are well over 20,000 scholarly journals, and even the best-funded libraries can afford subscriptions to only a fraction of them. OA offers authors a virtually unlimited, worldwide audience: the only barrier is internet access. There is a large and steadily growing body of evidence showing that OA measurable increases citation indices. For instance, of the papers published in the Astronomical Journal in 2003, 75% are also available in the OA arXiv database; the latter papers account for 90% of the citations to any 2003 Astronomical Journal article, a 250% citation advantage for OA. Repeating the exercise with other journals returns similar results.

Not only is this of vital importance to academics when it comes to applying for funding or competing for tenure, it's more or less inevitable that knowledge will be freely available to everyone, without restrictions or intellectual property or cost barriers. Similarly, Open Data is crucial by definition, and although you could的优势s, so one obvious focus of attention is government-funded research. Why should taxpayers pay twice, once to support the research and then again when the scientists are funding need access to the literature? Open access to a body of knowledge makes that knowledge more available and useful to researchers, physicians, manufacturers, inventors and others who make of the various socially desirable outcomes, such as advances in healthcare, that government funding of research is intended to produce.

Advantages for publishers: Not only is this of vital importance to academics when it comes to applying for funding or competing for tenure, it's more or less inevitable that knowledge will be freely available to everyone, without restrictions or intellectual property or cost barriers. Similarly, Open Data is crucial by definition, and although you could advantage of OA works also work to the advantage of publishers: more widely read, used and cited articles translates to more submissions and lower costs for advertising, paid editors and other value-added schemes.

Advantages for administrators: One of the best available metrics for research impact is citation counting: how many times has a given paper been cited by other researchers in their published work? This idea led to the development of the impact factor, a measure of a particular journal’s importance within its own field. These sorts of bibliometric indicators are relied upon heavily by science administrators making decisions about funding, tenure, and so on. Open access, by removing the barriers that prevent research literature from being accessible to anyone, makes that knowledge more available and useful to researchers, scientists, and the general public.

Maximal research efficiency. The usual version of Linsau’s Law says that, given enough eyeballs, all bugs are shallow. In the case of a scientific journal, the bugs will typically be discovered once. Even in a process that nearly every paper will be rapidly discovered and solved. The same is clearly true of complex research problems, and OA provides a way to take advantage of this. For example, Brody et al. showed that, for articles in the high-energy physics section of arXiv, the time between deposit and citation is decreasing steadily since 1995, and dropped by about half between 1995 and 2006. The Open Access movement in high energy physics is approaching maximal efficiency as a result of the early and free availability of articles that scien-

ists in the field can use and build upon rapidly.