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2002 April Meeting Features New SNO Data, CPU Study

More than 1200 physicists and astronomers attended the 2002 APS Spring Meeting, held April 20-23 in the beautiful southwest city of Albuquerque.

The principal subject areas were particle, nuclear, and astrophysics, including new data on neutrino oscillations (see page 3) and extreme hydrogen physics (see page 5). However, many other topics were covered as well, such as the final report of the NAS Committee on the Physics of the Universe (page 1), countering terrorism, women in physics, and the play "Copenhagen," about the wartime meeting between Werner Heisenberg and Niels Bohr.

The meeting was sponsored jointly by the APS and the high energy astrophysics division (HEAD) of the American Astronomical Society (AAS).

Next Linear Collider.

The panel of particle physicists (HEPAP) that advises both the US Department of Energy and the National Science Foundation has called for the construction, in the US or elsewhere, of a giant accelerator where beams of electrons and positrons would mutually annihilate in a burst of energy.

Moreover, an international steering committee has been set up to promote the project. What kind of machine is this "Next Linear Collider" and what are the physics goals? Speakers at a Monday session looked at the production of high energy beams at such a machine.

Other sessions featured talks about the specific physics experiments to be done, such as the detailed study of the Higgs boson, the elusive object thought to be responsible for the mass of other particles.

The Quest for Anti-Atoms.

Particle physicists are on the verge of creating cold anti-hydrogen atoms that can be manipulated and studied.

Gerald Gabrielse of Harvard University reported on his group's experiments at CERN that have combined antiprotons and positrons (antielectrons) in a trap. Obtaining definitive evidence for the existence of antihydrogen atoms in the trap is difficult and Gabrielse (a member of the ATRAP collaboration) discussed the status of the evidence for antihydrogen.

Another seeking to make anti-atoms at CERN (and a member of the ATHENA collaboration), Michael Holzscheiter of Los Alamos, examined how antihydrogen can be tested to see how closely it mirrors normal hydrogen, whether antimatter falls downward due to gravity and the implications for the most fundamental properties of the universe.

Gamma Rays: The Next Generation.

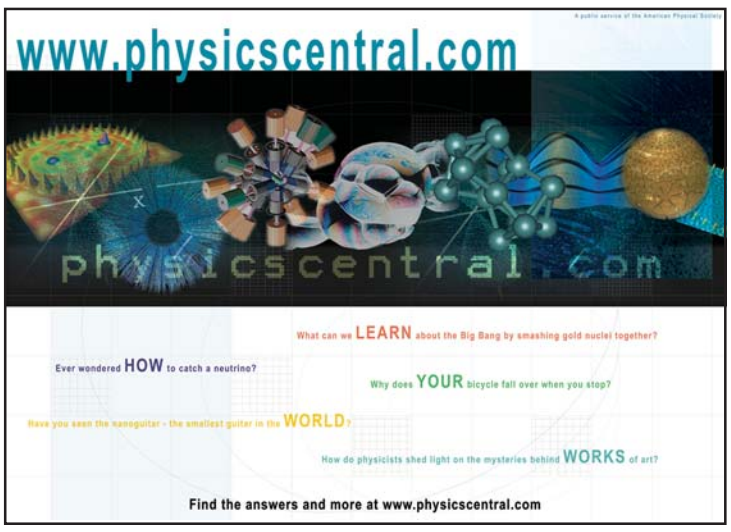
The orbiting Gamma Ray Large

See **APRIL MEETING** *on page 3*

Photo by David Sims

Mikulski, Walsh receive Public Service Awards

On April 10, the annual Public Service Awards sponsored by the APS together with the American Astronomical Society and the American Mathematical Society, were presented to Senator Barbara A. Mikulski (D-MD) and Representative James T. Walsh (R-NY) in a ceremony on Capitol Hill. Senator Mikulski is the Chair of the Appropriations subcommittee with responsibility for NASA and NSF, and Congressman Walsh is Chair of the corresponding subcommittee in the House. Both are champions of increased funding for these agencies and science in general. Shown here are Senator Mikulski (center) and Congressman Walsh (right) with their awards, being congratulated by APS President-elect Myriam Sarachik.



Designed by Kim Quigley

This spring, APS mailed over 21,000 of these posters to high school physics classrooms all around the US. As the public outreach web site of the APS, Physics Central (http://www.physicscentral.com) continues to grow in popularity among educators and the general public alike. The site is consistently ranked as the most popular in both the Yahoo! and Google physics directory listings and recently logged its millionth visit. Physics Central has also received accolades from numerous newspapers and periodicals, including the *New Scientist, Science* magazine, and the *Chicago Tribune*.

NSF Report Tracks Science Funding Patterns

The physicalsciences have been gravely under-funded relative to the life sciences in recent years. This was the conclusion, drawing on data contained in a report released by the National Science Board (NSB) at the end of April, that was reached both by the vice-chair of the NSB and by the chair of the NSB subcommittee that oversaw the preparation of the report.

The report, entitled "Science and Engineering Indicators 2002" is the fifteenth in a biennial series that is prepared by the National Science Foundation and submitted by the NSB (which is the governing board of the NSF) to the President. In two thick volumes, it contains a compilation of data on a wide variety of science-related subjects from education to funding to the position of the US in the global marketplace.

"On balance we're investing less in physical science and engineering and that gives me concern," said Anita K. Jones, Professor of Engineering and Ap-

See **NSF STUDY** *on page 5*

Scientific Societies Foil Potential Journal Scam

A Los Angeles-based journal subscription service has settled out of court to avoid a civil lawsuit by the APS, the American Institute of Physics, and two other scientific societies, alleging fraudulent business practices. Eastwood Books was alleged to have filed false society membership applications in order to obtain multiple subscriptions of scientific journals at the lower individual member rates.

The company also allegedly filed overlapping false claims for "missing" issues to assemble full sets of journals, subsequently sell-

See **JOURNAL SCAM** *on page 4*

CPU Study Issues Final Report

The National Academy of Sciences' Committee on the Physics of the Universe has completed its two-year-long study of physics and astronomy research and issued a final report, presented at the APS April Meeting in Albuquerque. Entitled "Connecting Quarks to the Cosmos," the final report outlines seven specific recommendations for research and research coordination to address 11 specific science questions at the interface of physics and astronomy [*see box on page 7*].

Chief among the recommendations are three new initiatives. Potentially most controversial is the construction of a deep underground laboratory (at least 4000 meters of water equivalent) aimed at determining neutrino masses and mixings, measuring the lifetime of the proton, and determining the constituents of dark matter. "[These issues] are all predictions of theories that unify the forces of Nature," said Michael Turner (University of Chicago), who chaired the study group. "Fully addressing all three requires a laboratory that is well shielded from the cosmic ray particles that constantly bombard the surface of the Earth." The committee identified three possible sites, including an extension of the existing Sudbury Neutrino Observatory in Ontario, Canada, and construction of a new facility in the San Jacinto mountains in Southern California. The Homestake mine in South Dakota is another possibility.

A second new initiative is the construction of a wide-field telescope in space to determine the expansion history of the universe and fully probe and characterize the nature of the dark energy. The third new project calls for the creation of a cosmic microwave polarization experiment, in the hope that measuring the polarization of the cosmic microwave background will help scientists detect the signature of inflation.

In addition, the committee added its support to three projects previously recommended by the National Research Council's 2001 survey report, "Astronomy and Astrophysics in the New Millennium," on the basis of their ability to address important problems

See **CPU STUDY** *on page 7*

The Primakoff Lecturer in Action

Photo by Jessica Clark

Lincoln Wolfenstein of Carnegie Mellon University delivers the Primakoff Lecture at the APS April Meeting in Albuquerque, on the topic of CP violation and neutrino mixing.

Highlights

Members in the Media

"It's not toxic or messy. And it's cheap. Experimentally, I love the stuff."
—*Ken Libbrecht, Caltech, on growing snow crystals in the lab, AP, March 31, 2002*

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"If you want to fracture a material with the least energy, hexagons are the way to do it."
—*Alberto G. Rojo, University of Michigan, on why lava flows form regular patterns, NY Times, April 2, 2002*

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"The coal industry alone is a $100 billion industry, and it could be replaced by charcoal. And the university could get in on it, if it wants to."
—*Michael Antal, University of Hawaii, on making charcoal from grass clippings, AP, April 1, 2002*

✶✶✶

"This is about trying to amass all the matter of the universe in a very small region. Good luck."
—*Stanley Deser, Brandeis University, on using principles of general relativity to build a time machine, Boston Globe, April 5, 2002*

✶✶✶

"LIGO gives us information that we don't have access to any other way, things like black holes, things we can only infer from the light we see."
—*Beverley Berger, National Science Foundation, AP, April 4, 2002*

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"10 or 15 years down the road, you might be able to connect a state-of-the-art electronic device to the human sensory system."
—*Peter Grutter, McGill University, Montreal Gazette, April 4, 2002*

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"The worst-case scenario is, really, to have a bunch of dummies in charge of the nuclear weapons. We want to make sure that the people who need to maintain those weapons are technically at the forefront of the science and engineering that's involved."
—*Raymond Jeanloz, University of California, Berkeley, National Public Radio's All Things Considered, April 7, 2002*

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"Physics is such a wonderfully logical framework that learning it benefits the other sciences."
—*Richard Olenick, University of Dallas, on the advantages of teaching physics before biology or chemistry in high school, Dallas Morning News, April 8, 2002*

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"The bottom line is, if you are really watching the game and you have a minimum of baseball experience, there's no way you should be hit by a foul ball."
—*Robert K. Adair, Yale University, on the danger to spectators at a baseball game, Calgary Herald, April 10, 2002*

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"A neutron star, because it is so dense, may be the only natural place in the universe where quark matter exists.We may have discovered a way of learning if the existence of free quarks is true."
—*Norman Glendenning, Lawrence Berkeley National Laboratory, on the possible discovery of quark stars, NY Times, April 11, 2002*

✶✶✶

"In fact it wasn't a stupid thing to do. There was no reason not to introduce it."
—*Steven Weinberg, University of Texas, on why what Einstein called his biggest blunder really wasn't, Dallas Morning News, April 15, 2002*

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"On average, the journey from one Web page to any other can be made in just 19 clicks."
—*Albert-Laszlo Barabasi, University of Notre Dame, on how the worldwide web is constructed, New Scientist, April 13, 2002*

✶✶✶

"In the top 20km of the Earth's crust, the conditions are right to produce a nearly inexhaustible supply of hydrogen."
—*Friedemann Freund, NASA, on the possibility of using Hydrogen to solve the world's energy problems, The Sunday Telegraph, April 14, 2002*

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"Even one war in space will [encase] the entire planet in a shell of whizzing debris that will thereafter make space near the Earth highly hazardous for peaceful as well as military purposes."
—*Joel Primack, University of California at Santa Cruz, CNN, May 3, 2002*

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"There's either a big rock at the center of Jupiter or there's not."
—*Robert Cauble, Lawrence Livermore National Laboratory, on unraveling the mystery of Jupiter's hydrogen process, Dallas Morning News, May 6, 2002.*

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This Month in Physics History

June 1871: Maxwell and his Demon

The notion of perpetual motion machines — *i.e.*, something capable of operating forever on a fixed supply of energy — has proven seductive. The U.S. Patent Office is inundated each year with applications for such devices, most of which it can reject out of hand thanks to the laws of thermodynamics. But one of the trickiest, and most famous evasions of the laws of thermodynamics was proposed by physicist James Clerk Maxwell, one of the pioneers of statistical mechanics, best known for the equations of electricity and magnetism that bear his name. Born in Edinburgh, Scotland in June 1831, Maxwell displayed a natural curiosity about the physical world at an early age, wanting to know how things worked even at the age of 3. He attended the Edinburgh Academy, where he emerged as a brilliant student, winning prizes for mathematics and English verse.

At 14, he wrote his first paper describing oval curves, which was presented to the Royal Society of Edinburgh.

He then studied mathematics and natural philosophy (physics) at the University of Edinburgh, publishing papers on the theory of rolling curves and the equilibrium of elastic solids, before moving to Trinity College at Cambridge University, earning a degree in mathematics in 1854.

Maxwell held various teaching positions before settling into the chair of natural philosophy at King's College in London, a six-year tenure where he did his most important experimental work on electromagnetism and studied the kinetic theory of gases.

In the latter, he demonstrated that molecules at high temperature have only a high probability of moving towards regions of low temperature, a more statistical approach than the concept that viewed heat as flowing inexorably from hot to cold.

To illustrate this point, in 1871, Maxwell proposed an intriguing thought experiment involving a clever microscopic creature, poised at a pinhole in a baffle dividing an insulated box into two equal chambers. The creature would try to wring regularity out of the randomness of molecular motion by picking and choosing among the motions. Specifically, it would sort molecules in such a way that the hotter (faster) molecules would be directed into one chamber while cooler (slower) molecules would be directed into the other.

Dubbed "Maxwell's Demon", this imaginary sorter itself requires energy to operate, and thus the segregation of hot from cold cannot really occur as described.

Nevertheless, the experiment is an excellent demonstration of entropy: Maxwell's demon manages to decrease the entropy, increasing the amount of energy available by increasing its knowledge about the motion of the molecules. But the laws of thermodynamics dictate that one can only increase entropy, or rather, one can only decrease it in one place if this is balanced by at least an equal increase somewhere else.

Real-life versions of Maxwellian demons — with their entropy lowering effects balanced by an increase of entropy elsewhere — do occur in living systems, such as the ion pumps that make our nervous systems work. And such molecular-sized mechanisms are also being explored in the new field of nanotechnology as scientists seek to put random molecular motions to good use.

In 1997 researchers at Boston College synthesized the first molecular ratchet, and have since been working to turn the rotor into a motor. Nanoforklifts are also envisioned, in which a particle would wriggle forward, encounter a desired molecule, and latch onto it. And as early as 1980, Charles Bennet of IBM argued that Brownian motion could be the basis for a computer, which would use jiggling to drive signals through, reducing voltages and heat dissipation.

More recently, a 1999 experiment conducted at the University of Essen in Germany yielded an initially surprising result: agitated sand in a two-chamber vessel (with the two halves connected by a hole) did indeed segregate, with the "hot" quickly moving sand migrating to one side and the cool sand spontaneously condensing and congregating on the other side.

However, Jens Eggers, who performed the experiment, says that the second law isn't really violated; although moving sand can be considered as a gas, individual grains can absorb and dissipate heat, unlike Maxwell's ideal gas, whose "temperature" is a measure of molecular motion. Thus, when sand grains start to congregate in one chamber, more and more grains will partake of a growing ordered state consisting of grains falling to the bottom of the container, while the unaffiliated grains will tend to be on the other side, still in "gaseous" form.

So even in today's cutting edge research, which continually pushes the boundaries of scientific knowledge, the Maxwellian Demon is an impossible beast. Unfortunately for those who chase after the pipe dream of perpetual motion, the laws of thermodynamics remain intact.

Reference:

J. Eggers, *Physical Review Letters* **83**, 5322 (1999).

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New SNO Data Resolves Solar Neutrino Problem

The solar neutrino problem has been settled and the ability of neutrinos to change from one type, or "flavor," to another established directly for the first time by the efforts of the Sudbury Neutrino Observatory (SNO) collaboration.

This finding gives physicists new confidence that they understand how energy is produced in the sun's core and that neutrinos are just as quirky as we thought.

The benevolent sunlight we receive on Earth has its origin in the sun's central fusion furnace, whence the light must fight its way outwards in a series of scatterings that takes, on average, hundreds of thousands of years.

Solar neutrinos, setting out from the same place, flee unhindered, thus providing the most unadulterated indication of activity at the core. Measurements dating back to the 1960's of this neutrino flux were puzzling: only a fraction of the expected number arrived at detectors on Earth.

Suspicion naturally fell on the experiments and on the standard solar model (SSM) used to calculate the flux. Soon, however, the neutrinos themselves were implicated.

If on their journey to Earth some of the neutrinos had changed into muon-or tau-neutrinos, then terrestrial detectors designed only to spot electron neutrinos (e-nu's) would be cheated of their rightful numbers.

SNO is a unique neutrino telescope, the size of a ten-story building, two kilometers underground in INCO's Creighton Mine near Sudbury, Ontario, operated by a 100-member team of scientists from Canada, the U.S. and the U.K.

It is designed to scrutinize a particular reaction in the sun: the decay of boron-8 into beryllium-8 plus a positron and an e-nu. The experimental goals are threefold: to prove neutrinos change their flavor; to measure the number of neutrinos coming from the Sun; and to determine the relative masses of neutrinos.

SNO's gigantic apparatus consists of 1000 tons of heavy water held in an acrylic vessel surrounded by a galaxy of phototubes, the whole residing 2 km beneath the Earth's surface in an Ontario mine, the better to filter out distracting background.

Last year SNO reported first results based on reactions in which a solar neutrino enters the detector and either (1) glances off an electron in one of the water molecules, or (2) combines with a deuteron to create an electron and two protons, a reaction referred to as a "charged current" (CC) interaction since it is propagated by the charged W boson.

The SNO data, when supplemented with ES data from the Super Kamiokande experiment in Japan, provided preliminary evidence a year ago for the neutrino-oscillation solution for

See **SNO DATA** *on page 6*

April Meeting Prize and Awards Recipients

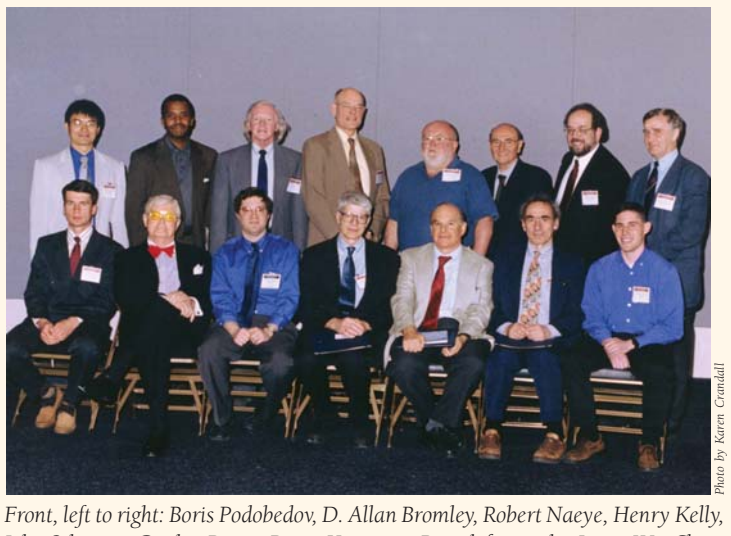


Photo by Karen Crandall

Front, left to right: Boris Podobedov, D. Allan Bromley, Robert Naeye, Henry Kelly, John Schwarz, Gordon Baym, Bruce Knuteson. Rear, left to right: Jiunn-Wei Chen, Keith Baker, J. David Bowman, James Cederberg, Adrian Melott, Alberto Sirlin, William J. Marciano, Alexander N. Skrinsky.

OPA Fellows Learn the Ropes on the Hill

Two young physicists are spending this year as policy fellows in the APS Office of Public Affairs in Washington, DC, as part of a new effort to provide further opportunities for scientists to gain valuable science policy expertise. Steve Pierson and Susan Ginsberg arrived in Washington in January and found themselves plunged headlong into the world of science and government.

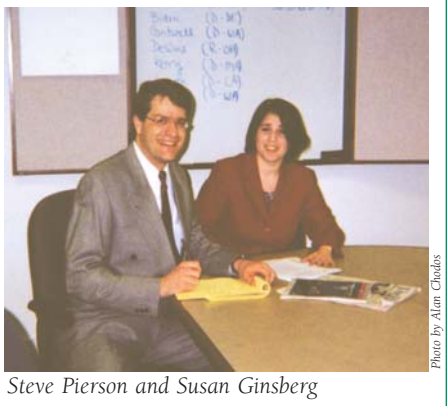


Photo by Alan Chodos

Steve Pierson and Susan Ginsberg

A native of North Dakota, Pierson attended Concordia College as an undergraduate before attending graduate school in physics at the University of Minnesota in Minneapolis, earning his PhD in condensed matter theory in 1993. He took a postdoctoral position at the Naval Research Laboratory and taught basic physics for a semester at Georgetown University before joining the faculty of Worcester Polytechnic Institute, 50 miles outside of Boston, Massachusetts.

Pierson earned tenure at WPI last year and wanted "to do something different" for his upcoming sabbatical year, preferably related to the societal aspects of physics. He heard about the new OPA fellowships through APS associate director of public affairs Francis Slakey, also an adjunct professor of physics at Georgetown, and signed on as a fellow. He has primarily worked on budget issues, organizing Congressional visits for APS members who come to Washington, spearheading letter-writing campaigns, and (with Ginsberg) operating the "Contact Congress" booths at the 2002 March and April meetings, each of which generated more than 1500 letters to Congressional representatives. (See picture on page 4.)

Ginsberg is also a native Midwesterner, growing up in Iowa and earning an undergraduate degree in geology from Amherst College before earning a master's in geophysics and a PhD in materials science engineering from the University of Minnesota in Minneapolis. Her thesis focused on studying rocks similar to those on the surface of Venus, and while she enjoyed the research — "I squeezed rocks for a living, how much more fun can you have?" — she decided her particular blend of skills would prove useful in government. While writing her thesis she volunteered in the Minnesota State Legislature working on air toxicity legislation, the first piece of which passed last year. The experience further whetted her appetite for public service.

Ginsberg came to Washington, DC in 2000 as a congressional science fellow with the Materials Research Society and the Optical Society of America, working in the office of Congressman Howard Berman [D-CA] on such issues as intellectual property, Internet policy, telecom, and the PATRIOT Act. Her work at the OPA has spanned such issues as science education, the Government Performance and Results Act (legislation aimed at getting agencies to use metrics for basic science research), and the controversial proposal to construct an underground laboratory at the Homestake gold mine in South Dakota.

As for the future, Pierson plans to return to WPI and resume teaching, although he would love to spend an additional year on the Hill. "As with a postdoc, you spend the first year learning the new material," he says. "In the second year you're able to take advantage of what you've learned." Ginsberg is undecided about what she'll be doing next, although she enjoys the atmosphere in Washington and would someday — "in the distant future" — like to run for public office.

APRIL MEETING, *from page 1*

Area Space Telescope (GLAST), scheduled for launch in 2006, is to be the successor to the highly successful Compton Gamma Ray Observatory. GLAST will study the cosmos by looking at objects that emit high energy photons. For instance, one onboard detector, the Large Area Telescope (LAT), will look for gammas with energies as high as 300 GeV.

The results of a balloon test flight from August 2001 of some GLAST components were reported at a Saturday session of the April meeting. The scientific targets for GLAST include some of the most violent events in the cosmos—gamma-ray bursters, active galactic nuclei—as well as the effort to map dark energy and to search for supersymmetric particles. (See http://www-glast.stanford.edu/)

New Data on Proton and Neutron Structure.

Last year, physicists working at Jefferson Lab in Virginia reported experimental evidence that the proton's electric charge was spread out, or distributed, in a different way than its magnetization current density.

At the April Meeting, Vina Punjabi of Norfolk State University in Virginia discussed new Jefferson lab data on the proton electric charge and magnetization current density distributions.

Andrei Semenov of Kent State reported similar measurements on the structure of the neutron, while John Ralston of the University of Kansas presented a theoretical explanation of the proton's differing magnetization current density and electric charge distributions.

Finally, Gerald Miller of the University of Washington presented an alternative explanation for the different distributions.

Spooky Action at a Distance.

In 1935, Albert Einstein published a paper with graduate students Boris Podolsky and Nathan Rosen in which they described a paradox (dubbed the EPR paradox after the authors) that Einstein called "spooky action at a distance" whereby one particle seems to affect instantaneously another particle a large distance away. Arthur Fine of the University of Washington and Martin Jones of Oberlin College each discussed the history and development of the EPR paradox and quantum entanglement.

In 1982, landmark experiments by Alain Aspect of the Institut d'Optique, France, tested the consequences of the EPR concepts and how it changed our notion of quantum reality. Aspect discussed that work and more recent developments that take advantage of progress in quantum optics.

Anton Zeilinger of the University of Vienna closed the session with a demonstration of how the originally problematic paradox is now driving new schemes for transmitting and processing information through quantum communication, quantum cryptography, quantum teleportation and quantum computation.

Hunting for New Physics.

Even as Michael Green (Cambridge) and John Schwarz (Caltech) received the 2002 Dannie Heineman Prize for their early work on the theory of superstrings, one of the pillars of modern particle physics, other scientists look for cracks in the standard model. Examples presented at the April meeting included new results from the measurement of the magnetic moment of the muon at Brookhaven, the measurement at Fermilab's NuTeV experiment of the parameter that sets the mixing of the weak nuclear force and electromagnetic force, the study of CP violation (antimatter not behaving quite like matter) at SLAC's B factory, the first physics from Brookhaven's Relativistic Heavy Ion Collider, and the mysterious spectrum of the highest-energy cosmic rays.

The Secret Life of Black Holes.

Black holes not only drive the latest science fiction stories but also the research programs of physicists exploring the fundamental structures of the universe.

Chris Fragile of Lawrence Livermore National Laboratory described simulations of black holes "eating" nearby matter, stars and gas clouds and the dynamics of those accretion flows. When two black holes try to swallow each other, the fabric of space-time undergoes extreme stresses.

Richard Price and Robert Owen of the University of Utah have investigated the downward spiral of two black holes orbiting one another, finding that a higher dimensional analogue of the black hole is the black string. Past research has indicated that black strings can split in two.

Matthew Choptuik of the University of British Columbia reexamines this issue in light of some contradictory predictions and presents the results of numerical simulations. But when is a black hole not a black hole? When it's a gravastar (a gravitational condensate star), according to LANL's Emil Mottola.

Science Goes Underground.

The U.S. is considering the prospect of building a major new science laboratory in South Dakota, specifically at the site of the Homestake Gold Mine in Lead, South Dakota.

The Homestake Mine was the site where neutrino measurements were made for many years and it remains a highly desirable underground location, shielded from the effects of cosmic rays and other environmental disturbances that can otherwise upset sensitive measurements.

Wick Haxton of the University of Washington discussed the prospect of a National Underground Science Laboratory at the Homestake site. According to Haxton, "This site provides great depth (to 8000 ft.) and valuable infrastructure, including massive shafts, hoists, ventilation, air conditioning, and communications systems and the presence of a skilled staff of engineers, geologists, and miners." He believes that the science possibilities at NUSL-Homestake are rich, spanning important topics in neutrino physics, dark matter, nucleon stability, nuclear astrophysics, supernova physics, earth science, materials science, and geomicrobiology.

Haxton provided an up-to-date report on the political and scientific progress in realizing the National Underground Science Laboratory.

Philip F. Schewe, Ben Stein, and James Riordon of the American Institute of Physics, and David Harris of the APS contributed to the technical coverage in this issue.

Photo by Jessica Clark

Dear Congress. . .

DPF Chair-Elect Jonathan Bagger of Johns Hopkins University watches as an April meeting attendee writes to her representative. With the help of a conveniently-located bank of computers, more than 1500 letters to Congress in support of the agencies that fund physical science were written at the April meeting.

LETTERS

Demystifying the Schroedinger Cat

It is time to stop all the nonsense about the Schroedinger cat [APS NEWS, March 2002). If the experiment is carried out and one waits a long time before the cage is opened and finds a dead cat, one also finds all the information to determine exactly when the cat died. Although we cannot predict beforehand exactly when the cat died, the cat is never in a coherent quantum state with an amplitude for being alive, an amplitude for being dead and a *definite relative phase* between the two amplitudes. There is no definite relative phase between the state of the live cat and the state of the dead cat and no interference can be observed between the two states.

In precise quantum-mechanical language, one can say that the state of an isolated radioactive nucleus is described by a wave function with a definite phase between the initial nuclear state and the final state where an alpha particle has been emitted. But as soon as there is any interaction, like having the emitted alpha particle break a box of cyanide, the quantum mechanical description of the system must also include the box of cyanide and the interactions involved in its breaking by the alpha particle. The state of the nucleus is no longer described by a wave function, but by a density matrix in which all the degrees of freedom of the cyanide box have been averaged out and all relative phases between the initial and final states of the nucleus have been randomized.

In this context the Schroedinger cat experiment is not really different from a classical chaos experiment in which a ball is moving chaotically in a box and has a certain probability of finding a hole where it can get out and break the box of cyanide.

The essential feature of quantum mechanics is not that a particle can be in two states and we don't know which. Ignorance is not quantum mechanics. The crucial difference between a classical description with ignorance and a quantum description is the existence of probability amplitudes and observable relative phases. There are no observable relative phases in the Schroedinger cat experiment. The fact that the observer who hasn't looked does not know whether the cat is alive or dead at a given time is simple ignorance, not quantum mechanics.

Harry J. Lipkin
Rehovot, Israel

g-2 Experiment is Rock Solid

I was surprised to read in the letter by Burton Richter ("Crotchety but Saintly", April 4, 2002) that he considered the g-2 experiment at BNL an example of a misplaced big claim. This experiment received a lot of attention when it indicated a 2.6 sigma deviation from the Standard Model.

However, when the theorists looked at their prediction more closely they discovered a sign error in their computer program, and the net result was a 1.6 sigma deviation. It should be noted that the experimental results, spearheaded for about 20 years by that master of precision experiments, Vernon Hughes, remained rock solid. Further data will come out this year. Perhaps Richter's argument was that everybody should have waited until the experiment reached its lowest error.

Alas, DOE plans eliminate any further running for this experiment after this year. So what are the experimenters to do: Should they act crotchety or saintly?

Peter Paul
Brookhaven
National Laboratory

Polygraph Should be Judged Objectively

I read Don Prosnitz' back page article [*APS NEWS*, April 2002] expecting imminently to come across his ideas for improving a key element in crime detection—credibility assessment—but was disappointed not to find it. Perhaps that is because the present best instrument, the polygraph, is in such disfavor in the liberal community despite its durability in police and security investigations. If that is the case, then we should be giving high priority to re-examining some of our value judgements.

One pertinent judgment is that the polygraph invades privacy and has a witness testify against himself. True, but if the trade-off is substantial enhancement of national security, perhaps we can no longer afford to be too choosy.

In any case we should approach the polygraph honestly and judge its worth objectively. A decade ago physicists questioned "The Scientific Validity of the Polygraph"—a disingenuous question, like asking when did you stop beating your wife. Obviously, the proper question is what is the best method of Credibility Assessment, and let the chips fall where they may. It is time we did just that.

Lawrence Cranberg
Austin, Texas

zero gravity
The Lighter Side of Science

Variations on a Theme by Dirac

The following poem was composed by Braulio Gutierrez-Medina, a graduate student at the University of Texas. It is compiled from works by two other authors: the non-italic script is from the book "The Physicist's Conception of Nature" *by Jagdish Mehra; the italic script is by Dirac himself, and comes from his Nobel lecture and from his book* "Principles of Quantum Mechanics".

My first meeting with Paul Dirac took place in Cambridge in 1955.

The new theories, if one looks apart from their mathematical setting, are built up from physical concepts which cannot be explained in terms of things previously known to the students, which cannot even be explained adequately in words at all.

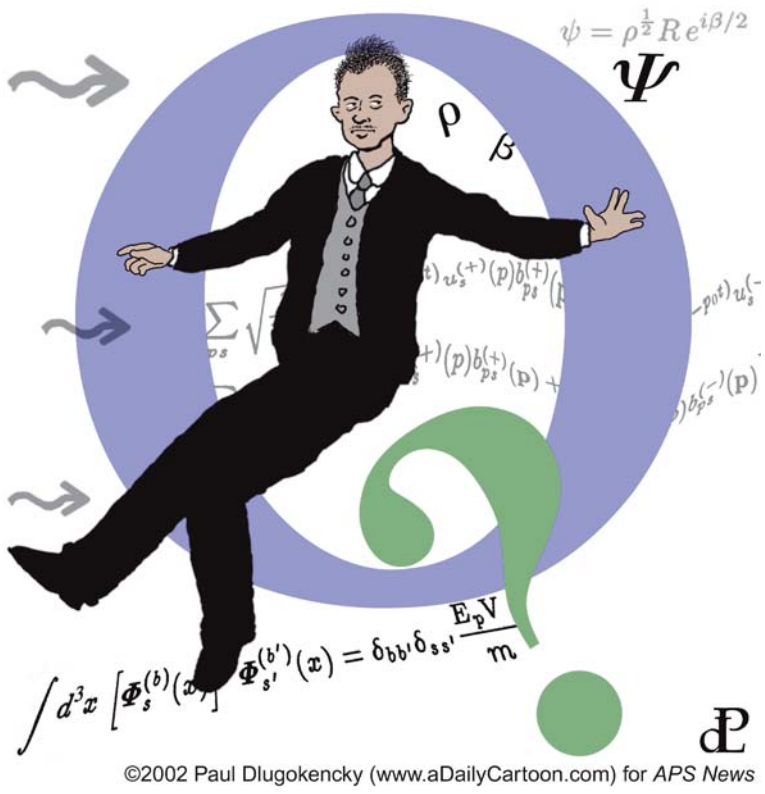
I had just returned to England after a couple of years with Heisenberg in Göttingen.

The amount of theoretical ground one has to cover before being able to solve problems of real practical value is rather large, but this circumstance is an inevitable consequence of the fundamental part played by transformation theory and is likely to become more pronounced in the theoretical physics of the future.

A historian friend of mine in Cambridge, knowing of my great hero worship for Professor Dirac, offered to take me with him to St. John's College, which was also his college, and to dine at the High Table.

Let us see how the basic ideas of quantum theory can be adapted to the relativistic point of view that the four dimensions of space-time should be treated on the same footing.

He thought we might see Dirac there.



©2002 Paul Dlugokencky (www.aDailyCartoon.com) for *APS News*

$$[W/c - \alpha_x p_x - \alpha_0 mc]\,\Psi = 0$$

I went with him, and true to his word, he showed me that Professor Dirac was sitting there.

These quantum equations are such that, when interpreted according to the general scheme of quantum, dynamics, they allow as the possible results of a measurement of W *either something greater than mc^2 or something less than $-mc^2$.*

We sat down.

We thus see that our equations allow for two kinds of motion for an electron, only one of which corresponds to what we are familiar with.

The weather outside was very bad, and since in England it is always quite respectable to start a conversation with the weather, I said to Dirac, "It is very windy Professor."

Thus in allowing negative-energy states, the theory gives something which appears not to correspond to anything known experimentally, but which we cannot simply reject by a new assumption.

He said nothing at all, and a few seconds later he got up and left.

We must find some meaning for these states.

I was mortified, as I thought that I had somehow offended him.

Any unoccupied negative-energy state, being a departure from uniformity, is observable and is just a positron

He went to the door, opened it, looked out, came back, sat down, and said

"Yes."

JOURNAL SCAM, *from page 1*

ing them to institutions overseas at rates as high as 10 times that of the individual membership rates. AIP, like APS, sells scientific journals at higher institutional subscription rates to companies, libraries and universities, while offering lower rates to individual scientists and researcher with society membership.

About 40 scientific societies were informed by a blanket email of Eastwood's resale of individual journal subscriptions to institutions, but it was AIP Executive Director Marc Brodsky who first took it seriously and approached the APS and other affected scientific societies about taking possible action. The APS, AIP, American Chemical Society and the IEEE approached Eastwood, eventually settling out of court for $250,000, which was received last December and divided among the four societies and other AIP member societies which had provided helpful subscription data.

Under the terms of the settlement, Eastwood Books, which did not admit any wrongdoing, has agreed not to place further subscription orders except at institutional rates, and has agreed to give the societies information about its subscription and distribution practices, which the societies hope will help them identify and bill Eastwood's overseas customers.

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According to APS treasurer Tom McIlrath, the APS eventually identified nearly a dozen individuals who defrauded the society by passing their journal copies to Eastwood, and ordering replacement copies to assemble completed sets. Neither the APS nor AIP has actively searched for patterns of abuse of its journal subscription practices in the past, preferring to focus on serving its members rather than chasing down potential abusers. However, it is believed that the conversion to electronic publishing will eventually allow greater control over journal

See **JOURNAL SCAM** *on page 5*

INSIDE THE BELTWAY: *A Washington Analysis*

Bringing Home the Bacon

By Michael S. Lubell, APS Director of Public Affairs

When Mitch Daniels, the Director of the Office of Management and Budget, summons you to a meeting on three days notice, you know that something is on his mind. When he asks you to attend a meeting on the second day of Rosh Hashanah, and he is aware that you are an observant Jew, you know that something is really troubling him. So you compromise your principles and go.

And go I did last fall. Amazingly, Daniels wanted to talk about pork, to a Jew, no less, on a High Holy Day. Depending upon your perspective, that's either irony or chutzpah.

Mitch Daniels, like every other Budget Director before him, wanted pork proscribed, just as it is writ in the Torah. But unlike any of his predecessors, he was enlisting a select group of scientists, about ten in number – just enough for a minyan – to carry the message to Congress: "Cease, or a veto shall be visited upon all your works."

"It's not just any pork, of which I want you to tell them to rid themselves," he declared, "it's scientific pork, the pork of bricks and mortar and special research projects that have had no peer review. It's the kind of pork that last year rose to almost $70 million in the Biological and Environmental Research account of the Department of Energy."

"And if we refuse to carry out your bidding," I ventured, "what will become of us?"

"All science shall suffer, and it will be known that you brought it upon your peoples," he warned.

"But what of projects, already peer reviewed and approved, that Representative Walsh and Senator Mikulski and their VA-HUD Appropriations brethren included in the National Science Foundation's Major Research Equipment account when they increased the NSF's budget?"

"Those, too, are pork," he said, "for the budget was too fat. We shall remove them within the year."

And that the White House did. Read the presidential budget carefully and you will find that almost every program in last year's spending bills not requested by the President has been skillfully excised from the FY 2003 budget request.

As you might imagine, Congress finds this kind of presidentially enforced budgetary diet most disagreeable. And members are already expressing their displeasure. Appropriators are busily planning to restore the excised programs, while authorizers are drafting legislation that will require agency heads to provide Congress with prioritized lists of peer reviewed projects.

If the voices of the science community are not heard, the Department of Energy, as has happened so many times in the past, could find itself penalized by the squabble between Congress and the White House over appropriations earmarking.

Here's how it might happen. The Energy and Water Development Appropriations bill always prove a tempting target for pork, particularly in an election year, such as this. Half a billion dollars is the earmark number being floated. And if it materializes, the DOE, which has the misfortune to draw its financial life from the same subcommittee that funds the water projects, could see its bottom line shrink substantially.

Congress is focusing on water projects to prove another point. In early spring, Mike Parker, once a Republican member of the House of Representatives, testified before his former colleagues, this time as the Assistant Secretary of the Army for Civil Works. His mandate was – you guessed it – the Army Corps of Engineers, the guardians of the water projects.

Parker was frank in his testimony: the Corps budget was too lean for the list of projects it had pending, lean to the extent of some 25 percent. The committee seemed receptive, and Parker returned to his office in the Pentagon certain that he had scored a victory. Later that day he was fired. Parker's former House colleagues are still seething over his treatment.

The science community faces two challenges, first to communicate to Congress that the DOE Office of Science should not be sacrificed in an internecine struggle over constitutional prerogatives and second, to communicate to the Office of Management and Budget, as well as Congress, that peer review and process transparency provide our nation with the strongest scientific enterprise. The stakes are too high for research and education to suffer as a result of a power struggle between the executive and legislative branches of government. Scientists must weigh in now.

FASTER, FASTER

Photo by Ed Lee

At the APS Teachers' Day at the April meeting, workshop participants took to the halls to simulate the motion of beam packets in a particle accelerator. Andrea Palounek, of the Los Alamos National Laboratory, led the workshop.

Taking Hydrogen to the Extreme

Hydrogen at extremely high pressures, upwards of a million times that on the Earth's surface, can now be produced in physics laboratories. Understanding hydrogen's behavior under such extreme conditions answers questions about the interior of Jupiter, provides coveted information on designing optimal fuel pellets for fusion energy, and yields information on aging nuclear weapons without having to test them. Reporting at the Albuquerque meeting, two national labs are producing seemingly contradictory high-pressure data on the universe's most abundant element.

Using Sandia's Z machine, which consumes tremendous amounts of electric current to generate very high magnetic fields, laboratory researchers launch a metal plate that travels at high speeds (up to 28 km/s, making it the fastest gun in the world) towards a target containing low-temperature deuterium molecules (D2). According to Marcus Knudson, who heads the group, the impact of the plate launches a shock wave that compresses D2 to up to megabars of pressure. Deuterium, a neutron-containing isotope of hydrogen, is used because its higher density enables it to be compressed to much higher pressures than ordinary hydrogen.

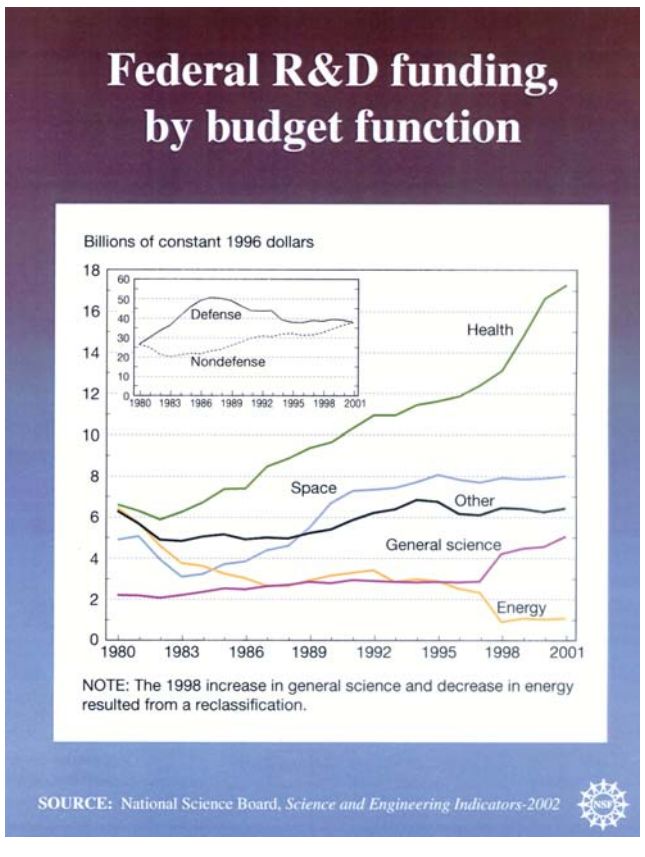
The Livermore experiments, on the other hand, used the high-power (and recently decommissioned) Nova laser to shock compress liquid D2. According to Livermore's Robert Cauble, his group finds D2 to be much more compressible than do the Sandia researchers. At a million atmospheres, for example, Livermore finds the D2 to be compressed by a factor of 6 while Sandia sees a compression of a factor of 4.

If the Livermore results are correct, then there is more metallic hydrogen in Jupiter's interior than previously thought and it is easier than expected to trigger self-sustaining nuclear fusion in deuterium fuel pellets, since they would be more compressible. If the Sandia results are right, then more traditional assumptions hold. But it's also possible, Cauble says, that both results are right (each group's compression occurs in slightly different time scales). As a final possibility, Cauble and Knudson admit, both results could be wrong (they are both relatively new techniques).

These possibilities are being carefully explored in conjunction with computer simulations of high-pressure hydrogen, which require the fastest available computers in the world. The question is likely to be settled with further experimental research, including more data from Sandia and future laser experiments, possibly occurring at Rochester's Omega facility. The ultimate goal of these experiments is to determine hydrogen's equation of state, the interrelationship between such properties as its pressure and temperature, at these high-pressure conditions. Such information can provide information on such things as the intriguing possibility that gas-giant Jupiter has a solid-rock core.

—Benjamin P. Stein

NSF STUDY, *from page 1*



plied Science at the University of Virginia and the Vice Chair of the NSB. "Disciplines are interdependent—you can't just make advances in one. They're strongly intertwined." The relative funding levels of the various disciplines are shown in the graph, which is taken from the NSB report.

Richard A. Tapia, Professor of Computational and Applied Mathematics at Rice University and the Chair of the NSB Subcommittee on Science and Engineering Indicators, said the government was being "very myopic regarding how much we've cut back on the physical sciences." He noted that other countries are now spending significantly more proportionally on the physical sciences, and predicted "we won't continue to be the best in a lot of these areas."

In illustrating how disciplines are intertwined, Jones pointed out that life expectancy has risen from 46 years to 76 years in the US over the last century. One might think that reflects mostly advances in medicine, but 2/3 of this increase is due to improved sanitation, in particular improved sewage and water purification systems. "That's engineering," she said.

Tapia, who is also an adjunct faculty member at the Baylor College of Medicine, said that many of his colleagues there are desperate to get help from computational scientists to interpret their data. But because of under-funding there is a shortage of such scientists, and the MD's often end up crying out in vain.

The complete Science and Engineering Indicators 2002 is available from NSF at http://www.nsf.gov/sbe/srs/seind02/ .

JOURNAL SCAM, *from page 4*

distribution and help to prevent further incidents of fraud.

"We hope this settlement has put a stop to activities that ultimately would deprive our legitimate individual members, our library customers who pay full and fair rates, and the entire scientific community of the full benefit of the exchange of scientific ideas presented in our journals," Brodsky said when the lawsuit settlement was announced in early April. "We also hope that this will discourage others from considering similar tactics, which we now will keep watch for and vigorously pursue."

While the civil suit has been avoided, a criminal investigation involving Eastwood Books is still ongoing, according to Detective Michael Yang of the Los Angeles Police Department, which conducted a warrant search of Eastwood's premises in Los Angeles. Detective Yang said he has no evidence that this investigation will uncover a larger organized effort to illegally sell scientific journals to underdeveloped regions, but can't completely rule out the possibility. However, "not everyone reads these journals," he cautioned. "You've got a select group of people and a selected market for it. So for somebody to defraud this type of organization, it's not something we see every day."

Council Passes Statement on Defense Funding

At its April meeting, the APS Council approved a statement on research and development funding in the Department of Defense. This statement, which had previously been approved by the Governing Board of the American Institute of Physics, deals not only with the overall levels of such funding, but also with the way that these funds are allocated among basic research, applied research, and development.

The text of the statement follows:

Department of Defense investments in research and development have paid very high dividends over the last fifty years. In the last decade alone, the United States has used its high-tech capability with great success in three conflicts: the Persian Gulf, the Balkans and Afghanistan. In each instance, US military objectives were accomplished with little loss of American life and relatively few direct civilian casualties. However, current defense research funding trends do not bode well for conflicts in the decades to come.

Today's array of military technologies — laser guided weapons, global positioning systems, stealth materials and night-vision systems, among them — were the result of a long-term DOD commitment to basic and applied research, carried out under the "6.1" and "6.2" programs. These programs, which draw heavily on the talents of the university community, presently total about $5 billion in annual spending, with roughly one third allocated to basic (6.1) research and two thirds to applied (6.2) research. For several decades, during a time when the American military has increasingly come to rely on its technological superiority, these accounts have remained essentially flat in constant dollars. This funding pattern places such reliance at extreme future risk.

Numbers are only one part of the story. For some time, defense policies have had the effect of reclassifying projects from one R&D category to another: development (6.3) relabeled as applied research (6.2) and applied research relabeled as basic research (6.1). This reclassification has severely compromised the long-term basic research programs that provide the seed corn for future defense technologies. In the interests of future national security this trend must be reversed.

Tomorrow's military capabilities depend heavily on the R&D choices the public makes today. Investments in the 6.1 and 6.2 programs must be increased, and the long-term basic research programs must not be sacrificed for short-term expediency. Future military strength requires it.

And the Winners Are....

The social hour sponsored by the Forum on Graduate Student Affairs at the APS April meeting featured the "FGSA Physics Quiz" in which teams of contestants vied for prizes such as a magnetically levitating "anti-gravity" top, and a "neutron" bounce ball. The first- and second-place finishers are pictured here. At right is the first place team from SLAC: Nicolas Berger (left) and Joerg Selzer (right); at left is the second-place team from UNC Chapel Hill and TUNL, consisting of (l to r): Ryan Fitzgerald, Carrie Rowland, Doug Leonard, and Brian Fisher.

SNO DATA, *from page 3*

the solar neutrino problem.

Now the definitive result has been tendered by SNO scientists at the Albuquerque meeting. The new findings update last year's CC and ES data and introduce, for the first time, evidence deriving from a reaction in which the incoming neutrino retains its identity but the deuteron (D) is sundered into a proton and neutron; this is why SNO went to such trouble and expense of using the D_2O for the weakly-bound neutron inside each D. This interaction, called a neutral-current (NC) reaction because the weak interaction is carried by a neutral Z boson, is fully egalitarian when it comes to neutrino scattering; unlike last year's ES data, the NC reaction allows e-nu's, mu-nu's, and tau-nu's to scatter on an equal footing.

The upshot: all the nu's from the sun are directly accounted for. The missing nu-e flux shows up as an observable mu-nu and tau-nu flux. This conclusion is established with a statistical surety of 5.3 standard deviations, compared to the less robust 3.3 of a year ago. The measured e-nu flux (in units of one million per sq. cm per second) is 1.7 while that for the mu-nu and tau-nu combined is 3.4. (When one includes neutrinos of all energies, the flux from the sun is billions/sq. cm/sec.)

"It was a dramatic and exciting moment for us when we first saw the neutrons being produced by this type of neutrino interaction and realized there were three times as many as you would get if only electron neutrinos were coming from the Sun," said Hamish Robertson of the University of Washington, one of the collaboration scientists. "There's absolutely no question the neutrino type changes, and now we know quite precisely the mass differences between these particles."

The issue of how the neutrino changes from one flavor to another can even be addressed by viewing the day-night asymmetry of neutrino flux. When the whole of the earth is between the sun and the detector (night viewing), the oscillation process, which depends on a density of matter through which the nu proceeds, should be speeded up. This type of measurement also contributes to the study of neutrino masses and mixings.

An experiment like SNO can measure not mass but the square of the mass difference between nu species. Even if the nu mass is quite small (much lighter than the previously lightest known particle, the electron) it might still have played a large role in cosmology, where it might have been instrumental in shepherding galaxies; in supernovas, neutrinos might carry away as much as 99% of an exploding star's energy.

Editor's Note: The SNO team has submitted its results to *Physical Review Letters*; preprints are available at the online preprint server: nucl-ex/0204008 and 0204009; see also www.sno.phy.queensu.ca.

Viewpoint...

Achieving Mathematical Physics for All High School Students

by Stewart Brekke

Around 1983, I was assigned to teach physics and math to every student, except slow learners, at Paul Robeson High School in Chicago.

The school was so completely isolated in the black neighborhood of Englewood, the students could not be effectively bused to white neighborhoods in accordance with integration practices.

Therefore, the school was required as a compromise to offer four years of mathematics and science to every student. Being assigned to this school was a very fortunate experience for me, because I found that, contrary to common assumptions, all students, average and above, could do the standard mathematical physics course normally reserved for only the upper 25% or so of each American high school.

The mistakes many texts make in high school and college is that there are usually three or four different types of problems, each one uniquely solved with no examples provided. This format was disastrous for the ordinary student with little capacity to get outside help, *e.g.* from a cousin in engineering or physics in college.

However, I found that most students, from the average to the most intelligent, from the most motivated to the most at risk, can do physics problem solving if they are given individual help at least at first in the course, gradually being provided with less assistance as the school year progresses. They learn to solve physics problems because the teacher shows them how to do the first problem and then lets the students solve a few more of the same type.

In my experience, it takes almost an entire semester for most students to get the hang of how to use a formula and scientific notation successfully to solve a problem on their own. But even at-risk students can do more complicated problems involving the solving for two or more variables in different steps, if an example is shown on an individual basis and the student is then required to solve three more similar problems. It's a method that has been used by the mathematics community for years.

There are some drawbacks to teaching average and at-risk students. Their lack of facility with decimals, fractions, long division and algebra must be offset with a ready supply of cheap arithmetic calculators and/or scientific calculators such as the TI-30. As the course progresses, the students become more proficient with their algebra and remember how to use exponents, solve for different variables, use square roots and trigonometric functions. This also helps prepare them for real science in higher education.

In addition, labs in the inner city and high level magnet schools were of the "string and sticky-tape" variety. The students always took data, often graphed the data, and modeled it if we had time. To complete a physics lab in the allotted 50-minute time frame is difficult, so often I would help the students set up the apparatus after they copied down a skeleton format from the board, and helped them start taking data. For years, students were stymied on setting up apparatus and often incomplete data was taken. With assistance given to them in the early stages to save time, the students were able to get a better idea of what the lab work was all about.

By making the mathematical high school physics course "user friendly," yet substantive, with good quality problem solving and labs, I passed more students that other teachers at the high school, some of whom failed as many as 90% of their students. Many teachers had given up on these students, gave them a watered-down qualitative course which virtually wasted their time, and did not enhance their potential for well-paid, satisfying careers in science or science-related fields.

However, I found that adolescent girls with two children, gang-member boys and girls, athletes, hair dressers and carpentry majors, to name a few, could do the same mathematical course given to the top students, if direct instruction were given with drills and practices, and an emphasis on developing skills rather than theory.

I believe that the physics departments in higher education must use the principles of educational psychology to enhance learning in high school physics as well as at the university, and not simply require more physics competence of candidate teachers. And high school physics teachers must be prepared to put in a good deal of time and sometimes money to enhance the user friendliness of their physics courses to reach average and at-risk students.

There is solid physics potential in the inner cities, but we have to go out of our way to reach these students. Almost every night for the entire school year I put in between two to four hours of lesson preparation, and many professors do the same. But I can say I walked out of the inner city high schools of Chicago with my head held high because I did not "sell out" my students with a watered-down qualitative course.

Stewart Brekke is a former teacher of physics and chemistry with the Chicago Public Schools, now retired.

ANNOUNCEMENTS

June 15, 2002 is the deadline for the 2002 APKER Awards

For Outstanding Undergraduate Student Research in Physics

Endowed by Jean Dickey Apker, in memory of LeRoy Apker

▶ QUALIFICATIONS

- Students who have been enrolled as undergraduates at colleges and universities in the United States at least one quarter/semester during the year preceding the **JUNE 15, 2002** deadline.
- Students who have an excellent academic record and have demonstrated exceptional potential for scientific research through an original contribution to physics.
- Only one candidate may be nominated per department.

▶ APPLICATION PROCEDURE

The complete nomination package is due on or before **JUNE 15, 2002** and should include:

1. A letter of nomination from the head of the student's academic department.
2. An official copy of the student's academic transcript.
3. A description of the original contribution, written by the student such as a manuscript or reprint of a research publication or senior thesis (unbound).
4. A 1000-word summary, written by the student, describing his or her research.
5. Two letters of recommendation from physicists who know the candidate's individual contribution to the work submitted.
6. The nominee's address and telephone number during the summer.

▶ DEADLINE

Send name of proposed candidate and supporting information by **JUNE 15, 2002** to: Dr. Alan Chodos, Administrator, Apker Award Selection Committee; The American Physical Society; One Physics Ellipse, College Park, MD 20740-3844; Telephone: (301) 209-3268, Fax: (301) 209-3652, email: chodos@aps.org.

Contributions Acknowledged Online

APS recently initiated a special web page to acknowledge the generous contributions from the Society's individual donors.

During 2001, an impressive number of APS members provided an annual gift in conjunction with their membership renewal, including more than 800 donors who gave $100 or more.

Many individuals also supported APS prizes and awards fundraising efforts. By making a contribution, APS members help further the Society's education and outreach initiatives, international affairs programs, public information efforts and recognition of scientific accomplishments through prizes and awards. We very much appreciate all of these gifts.

The listing can be viewed by APS members on the Development Department's webpage at http://www.aps.org/development.

PROPOSED AMENDMENT TO THE APS BYLAWS

Regarding the Establishment of a Prize and Award Advisory Committee

In 2001, the APS President appointed a Task Force to review the APS Prize and Award Program. One of the recommendations made by this task force called for the establishment of a standing prize and award advisory committee. The committee would be charged with two main duties;

1.) To review proposals for new prizes and awards in light of current guidelines and make recommendations concerning these proposals to the Executive Board and Council; and

2.) To conduct an in-depth review of each prize and award at least once every 5 years to insure all prizes and awards are properly funded and that subject areas of each prize or award remains relevant.

The APS Council voted in November 2001 to move ahead with this recommendation and charged the Constitution and Bylaws committee with drafting a Bylaws amendment creating a Prize and Award Advisory Committee (PAAC). The proposed amendment was approved in its first vote by the Council on April 19, 2002:

ARTICLE III – Standing Committee
A. Operating Committees

10. Prize and Award Advisory Committee. The membership of the Prize and Award Advisory Committee shall consist of six Councillors, appointed by the President-Elect to staggered three-year terms, which may include one year of service beyond their term as Councillor. The President-Elect shall appoint the Chairperson from among these six members. The Committee shall review all proposals for new prizes and awards and make recommendations to the Executive Board and Council. It shall review all existing Society prizes and awards at least once every five years to insure they are properly funded and that the subject area of each prize and award remains relevant. The Committee shall also ensure that prize and award selection committee members represent the broadest possible context of the prize or award subject area and consider any other administrative issues related to prizes and awards.

Now Appearing in RMP...

The articles in the July 2002 issue of Reviews of Modern Physics are listed below. For brief descriptions of each article, consult the RMP web site at http://www.phys.washington.edu/~rmp/current.html. George Bertsch, Editor.

The holographic principle — Raphael Bousso
Charge-transfer dynamics studied using resonant core spectroscopies — P. A. Brnhwiler, O. Karis, and N. Msrtensson
Superfluid 3He Josephson weak links — J. C. Davis and R. E. Packard
Technical approaches for high-average-power free-electron lasers — George R. Neil
Nobel Lecture: Bose-Einstein condensation in a dilute gas: the first 70 years and some recent experiments — E. A. Cornell and C. E. Wieman
Theory of ultrafast phenomena in photoexcited semiconductors — Fausto Rossi and Tilmann Kuhn
Origins of galactic and extragalactic magnetic fields — L. M. Widrow
Colloquium: The future of double-beta-decay research — Yuri Zdesenko

Reviews of Modern Physics University of Washington; Physics/Astronomy B428; Box 351560; Seattle WA 98195; rmp@phys.washington.edu • phone: +1 (206) 685-2391

Michelson Postdoctoral Prize

Call for Nominations

The Michelson Postdoctoral Prize is given annually by the Physics Department at Case Western Reserve University to an outstanding postdoctoral researcher in any subfield of physics, based on an international solicitation for nominations from senior physicists.

The Prize for 2002 has been awarded to astrophysicist Re'em Sari of Caltech for contributions to the theory of gamma ray bursts. Previous winners include Thomas Walter (Texas A&M, 1998), Christopher Fuchs (Caltech, 1999), Joe Mohr (Univ Chicago, 1999), Keith Schwab (Caltech, 2000) and Jonathan Feng (MIT, 2001).

More information on making nominations for the 2003 Michelson Postdoctoral Prize Lectureship is available at http://erebus/events/mppl.php

CPU STUDY, *from page 1*

in astronomy. The CPU group determined they would also address science at the interface of physics and astronomy. They are the Large Synoptic Survey Telescope (LSST), intended to probe the dark energy by weak gravitational lensing; the Laser Interferometer Space Antenna (LISA), designed to test GR by detecting gravity waves from colliding massive black holes; and the Constellation X (CON-X) Observatory's mission, aimed at probing the event horizon of black holes.

Finally, the report calls for determining the origin of the highest energy gamma rays, neutrinos and cosmic rays, adding its support for the broad approach currently in place and recommending that the U.S. ensure the timely completion and operation of the Southern Auger array in Argentina, which the committee deems "crucial for solving the mystery of the highest energy cosmic rays."

The committee recommended the establishment of an Interagency Initiative on the Physics of the Universe, with the participation of the DOE, NASA and NSF, intended to provide structures for the joint planning and mechanisms for joint implementation of cross-agency topics. The agencies should also cooperate in bringing together the different scientific communities that can foster the rapidly developing field of extreme astrophysical environments through the laboratory study of high-energy-density physics. "The field is in its infancy, and to fulfill its potential, it must draw on expertise from astrophysics, laser physics, magnetic confinement and particle beam research, numerical simulation and atomic physics," said Turner

***Editor's Note**: Copies of the full CPU report, "Connecting Quarks to the Cosmos," can be obtained by contacting Joel Parriott at the NAS, 202-334-3520, Jparriot@nas.edu, or Dick Rowberg, 202-334-3226, Rrowberg@nas.edu.*

The CPU study group identified 11 questions that they believe encapsulate most of the topics at the physics and astrophysics interface that we have a good chance of answering in the next few decades. Taken as a whole, the questions below address an emerging model of the universe that connects physics at the most microscopic scales to the properties of the universe and its contents on the largest physical scales.

1. What is the dark matter?
2. What is the nature of the dark energy?
3. How did the universe begin?
4. Did Einstein have the last word on gravity?
5. What are the masses of the neutrinos, and how have they shaped the evolution of the universe?
6. How do cosmic accelerators work and what are they accelerating?
7. Are protons unstable?
8. Are there new states of matter at exceedingly high density and temperature?
9. Are there additional spacetime dimensions?
10. How were the elements from iron to uranium made?
11. Is a new theory of matter and light needed at the highest energies?

Scientists Observe Evidence for Possible Quark star

An excellent example of exciting research at the interface of physics and astronomy is the recent announcement of evidence for quark stars, which comes in the form of observations of a pair of collapsed neutron stars that may be composed of an entirely new form of matter. The stars were viewed at x-ray wavelengths by the Chandra x-ray telescope and in the visible region by the Hubble Space Telescope.

Quark stars are what you might get if a collapsing star were to proceed beyond the neutron-star regime in which the star is comprised chiefly of neutrons to a condition in which the neutron "bags" would be dissolved, allowing the quarks to run together. Brookhaven's RHIC collider attempts to do something like this on a much smaller scale when it smashes together two gold atoms. In the case of a quark star, it is immutable self-gravity rather than man-made accelerator gradients that provide the needed crushing power. Under these conditions, it might be energetically feasible for many quarks to exist as strange quarks rather than the lighter up and down quarks, hence the name "strange stars."

The two stars in question were examined in unprecedented detail by the two separate teams of researchers. One of the observed objects, RXJ1856, is too small — judging by its wealth of x-ray and dearth of visible emissions — to be a conventional neutron star made primarily of neutrons. The other object, 3C58, seems to have cooled too quickly — judging by its present measured warmth and known lifetime, drawing upon medieval Chinese records of the object's birth as a supernova in 1181 CE — to be an ordinary neutron star. In both cases, the observations tally better with a star comprised of quarks in one big nucleus, or a mix of quark and neutron layers.

If confirmed, the stars would provide unexpected insights into how the universe is put together at the most fundamental level, and how it evolved in the fractions of a second after the big-bang birth of the cosmos. Nevertheless, some doubt remains as to whether the observations are truly consistent with the existence of a quark star. One day after the press conference at which the initial results were announced, a new preprint appeared which suggests that the distance to RXJ1856 is actually further away than the earlier estimate, and that the object need not be a quark star at all.

Astronomer Frederick Walter (State University of New York, Stony Brook) believes that our ignorance of the star's temperature and chemical composition make its diameter uncertain. "These results are not definitive," said Michael Turner, as astrophysicist at the University of Chicago, adding that studies of other bodies are needed to confirm whether quark stars really exist. But Chandra's observations do show how the extreme regions of space can be used to test physical theories, essentially turning the universe into a "heavenly laboratory."

References:

Astrophysical Journal:

3C48 preprint, Slane et al., astro-ph/0204151

RXJ1856 preprint, Drake et al., astro-ph/0204159

See also: astro-ph/0204199

THE BACK PAGE

Reflections on the American Physical Society in 2002

By George Trilling

Photo by Martin Blume/APS

George Trilling

Near the end of last year, I wrote letters to some of my physicist colleagues, not presently APS members, urging them, as convincingly as I could, to join our Society. I tried to explain the reasons, aside from receiving Physics Today, as to why our organization was worth their support, even at the cost of a $100 membership fee. I did so by describing many of the important APS activities and issues, with special emphasis on the last year (2001). I share some of these here with a wider group.

Perhaps first and foremost, the APS is in the business of publishing world-class scientific journals. A recent comment from the Publication Oversight Committee describes well the APS effort: "The electronic revolution means that we are traveling into uncharted waters, and we struggle with how best to steer the APS Publishing Ship. Thanks to superior foresight and management, the APS journals are doing fantastically well, but we always want to improve and do things better."

The year 2001 saw major progress in the APS publications enterprise: Physical Review On-Line Archive (PROLA) completed all the way back to the PR beginnings in 1893; establishment of a PROLA mirror site at Cornell University; beautiful color images for PRL covers; the continuing success of Physical Review Focus; the organization, in collaboration with the American Institute of Physics (AIP), of two new virtual journals on "Applications of Superconductivity" and "Quantum Information"; and progress toward the institution of a fully electronic editorial office.

Unfortunately the cost per subscription of our journals grows faster than inflation, for two reasons: each year, submissions increase by a few %, and nonmember (library) subscriptions drop a few %. The increase in yearly submissions is almost entirely associated with growing inputs from outside the U.S. which now amount to 70% of total submissions, equally distributed between Western Europe and the rest of the world. The development of creative charging models that keep this publishing enterprise financially sound, on terms both fair and affordable to libraries, is a continuing major challenge. Fortunately our Editor-in-Chief and our Treasurer, backed up by an extraordinarily dedicated staff, have proven to be true pioneers in this new world. They are hoping to achieve yet further economies by shifting to a fully electronic office environment while maintaining the daily routine of about 100 new submissions.

For the future, our publishing enterprise will face continuing challenges, raising questions over such issues as: i) the time scale on which print journals disappear, ii) the future of peer review, iii) future responsibility for archiving in a world of rapidly evolving technology, and iv) the overall impacts of new technologies.

Moving to public affairs, The Society has a natural role, given the fact that many current public policy issues require sound scientific and technical input (as well as as political, economic and other inputs). Examples of such issues include energy production, the environment, missile defense, visa policy, homeland security etc.

I mention two examples of important APS activities related to public policy, started or completed in the last year. Both originated with the APS Panel on Public Affairs (POPA). The first is a report entitled "Nuclear Energy: Present Technology, Safety, and Future Research Directions: a Status Report" from a distinguished group of experts. It is posted on the POPA web site, and I invite you to study it. The second is the "APS Study of Boost-Phase Missile Defense " under way since early 2001 under the joint leadership of Dan Kleppner (MIT) and Fred Lamb (U. of Illinois). The Study Group of twelve outstanding engineers and physicists, who are volunteering a great deal of time and effort, will, in the next few months, submit a report based on fundamental science and engineering, and on unclassified information. This report, devoted solely to relevant scientific/technical issues, should have considerable impact.

Another aspect of the APS public affairs activity is motivated by the inadequacy of the federal funding levels for both physics research and the improvement of K-12 science education. There is continuing concern about balance in research support: of the total federal basic and applied research funding proposed for FY2003, the NIH gets about 50%, whereas DOE receives 10% and NSF 7%. Over the last few years, while the NIH budget has doubled, NSF support has increased only modestly, and DOE, the largest federal supporter of physical science, has stagnated. The APS Office of Public Affairs (OPA) is working hard to encourage improved federal support of research in physical science and science education. At recent March and April meetings, an impressive computerized system has been deployed to make it easier for attendees to communicate with their members of Congress. OPA has also worked with congressional staff to help craft legislative language, and has organized effective congressional visits programs. It was my privilege to testify twice in 2001 before congressional committees, and others in the APS leadership also testified last year, and will do so again this year.

As mentioned above, funding for the DOE Office of Science programs has at best remained flat for many years, even though the national labs and their sophisticated user facilities have helped produce world-class science. To help address this situation, APS Physics Policy Committee Chair Richardson and APS President Langer convened, in the fall of 2000, a distinguished panel to consider organizational ways of giving the DOE Office of Science more visibility and better recognition of its leadership role in the nation's scientific enterprise. One of its proposals was to create within DOE a new high-level position of "Under Secretary for Science and Energy Research and Science Advisor to the Secretary". This idea has already received some support on the Hill, and has a chance of being implemented in the not too distant future. I believe that it could be an important step forward.

Science is of course universal, and the advancement and dissemination of the knowledge of physics are vigorously pursued all over the world. As physics facilities, such as particle accelerators and detectors, neutron sources, space vehicles etc. become increasingly costly, international collaboration can make them more affordable. The APS is playing an active role in promoting and facilitating international efforts. In 2001, it helped organize the Inter-American Workshop on the Use of Synchrotron Radiation for Research and Symposium on Nanosecond Technologies in Brazil. There was a Joint Meeting of the APS Division of Nuclear Physics and the nuclear physicists from the Japanese Physical Society in Maui in October 2001. The Summer saw a DPF/DPB Workshop on future directions in Particle Physics, held in Snowmass and attended by particle and accelerator physicists from across the globe. Their recommendation of a Linear Electron-Positron Collider as the next major particle accelerator facility is only conceivable as a large international collaborative effort.

A variety of security concerns have, in recent times, led to increased difficulties and delays in the granting of U.S. visas, for both short-term attendees of scientific conferences and long-term visitors coming to collaborate in U.S. research programs. Foreign visitors working in the U.S. and traveling to meetings abroad have found themselves stranded, with their returns to the U.S. long delayed. The APS Office of International Affairs has been active both in assisting with individual visa problems, and in interacting with the State Department to promote the possible formulation of new visa rules that do not inhibit long-term visits.

There are numerous other areas of activity, but I am running out of space. I conclude by noting with enthusiasm that physics research continues to yield exciting surprises...dark energy and dark matter, neutrino mass and oscillations, new superconducting materials, new manifestations of quantum phenomena etc. It underlies many of the technological developments crucial to the health of our economy and to our security, and provides tools that help advance other scientific enterprises including biology and medicine. The health of that research enterprise depends on increased federal funding support, especially for the DOE Office of Science and for the NSF, and also depends on continuing improvement of science education at all levels from kindergarten through university. With the strong leadership of its operating and elected officers, the efforts of its dedicated staff, and the active participation of a large membership, the American Physical Society will continue to play a major role in promoting all these directions.

George Trilling, Professor Emeritus at the University of California, Berkeley, and Faculty Physicist at the Lawrence Berkeley National Laboratory, was President of the APS in 2001. This article is adapted from his retiring Presidential Address, delivered at the APS April meeting.

April Meeting Attendees Visit Ground Zero

On the last day of the APS April meeting in Albuquerque, four busloads of physicists, together with accompanying persons and some members of the science press, headed for the Trinity Site, a little over a hundred miles away, where the first atomic bomb had been exploded in the early morning of July 16, 1945. Because the site is within the White Sands Missile Range, it is normally closed to the public, and special permission had to be obtained for the group to make its visit.

The explosion vaporized the 100-ft. tower from which the bomb was suspended, and caused the top layer of sand for hundreds of yards around to fuse into a greenish glassy substance now known as "trinitite". Because it was radioactive, most of it has been removed, but some is still protected by a low-lying shed about 100 yards from Ground Zero. In the top photo, White Sands public affairs officer Jim Eccles gestures at the trinitite while members of the tour look on. The photo at left shows what remains of a water tower at the McDonald ranch about 2 miles from Ground Zero—the blast destroyed the windmill on top of the tower but spared the rest of it because of the lay of the land. At far left is pictured the obelisk at Ground Zero itself. The person in the foreground is bent over in characteristic trinitite-hunting mode.

At bottom, a member of the tour takes a picture of one of the historical photographs that are stored in the McDonald ranch house, where the plutonium for the bomb was assembled before being transported to Ground Zero for the test.

Photos by Jessica Clark

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.