APS NEWS

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IUPAP Declares 2005 "World Year of Physics"; Franz Elected Secretary-General

Resolutions declaring 2005 the "World Year of Physics" and providing a roadmap for enhancing the role of women in physics were among the actions taken during the 2002 General Assembly of the International Union of Pure and Applied Physics (IUPAP), held October 9-12 in Berlin, Germany. IUPAP also held its general election, in which APS Executive Officer Judy Franz was chosen as Secretary-General for a three-year term, succeeding René Turlay of C.E.N. Saclay. The new President of IUPAP will be Yves Petroff of the European Synchrotron Radiation Facility in Grenoble. He succeeds Burton Richter of SLAC.

Hard at work at the IUPAP General Assembly are (l to r): Robert Barber of the University of Manitoba, Judy Franz of the APS, and Burton Richter of Stanford.

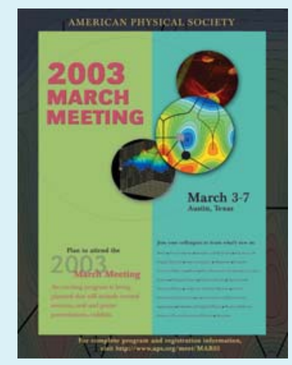
Photo by Martina Wanke and Holger Dietz

First proposed by the European Physical Society (EPS), the "World Year of Physics" is intended to raise worldwide public awareness for physics. The choice of 2005 refers to the 100th anniversary of the year that Albert Einstein wrote legendary papers that made fundamental contributions to three areas of physics: the theory of relativity, quantum theory, and the theory of Brownian motion. The APS will be participating in the event by coordinating a variety of outreach and public information activities in the US; more information will appear in *APS News* as the plans begin to take shape.

Franz was one of several American physicists elected to IUPAP office, and she declared herself "honored" by her selection. But for her, a more personal triumph was the passage by the IUPAP General Assembly of a Resolution on enhancing the role of women in physics. The resolution was an outgrowth of the first International Conference on Women in Physics held earlier this year in Paris, France, which was attended by more than 300 physicists from 65 countries [see *APS News*, May 2002].

The General Assembly approved strong declarations establishing fully equal opportunity for success in physics independent of gender, in all arenas: primary and secondary schools, colleges and universities, research institutes and industry, professional societies, national governments, and funding agencies. Yet the most important provisions, according to Franz, were the recommendations IUPAP made to itself that women be appointed to its liaison committees; that gender be a consideration in nominations to commissions and to the Council, and the statement declared that it expects that IUPAP-sponsored conferences will have women as members of their program committees. She credits the success of the Paris conference and the reports generated for it with helping to boost broad support for women in physics issues within IUPAP's General Assembly.

Yee-Haw! March Meeting Heads Down to Austin, Texas



Next spring some 5000 physicists will head southwest to Austin, Texas, the self-proclaimed American capital of live music, for the 2003 APS March Meeting, to be held March 3-7. Approximately 5000 papers will be presented in more than 90 invited sessions and 550 contributed sessions in a broad range of categories, including condensed matter and materials physics, biological, chemical, computational and high polymer physics; atomic, molecular and optical physics; magnetism and industrial and applied physics.

See MARCH MEETING *page 4*

APS News Asks Readers to Pick Historic American Physics Sites

What sites best represent the history of physics in America? The APS Forum on the History of Physics (FHP) says it wants to know, and moreover it is interested in participating in a program to place commemorative plaques at the chosen sites.

APS News would like to help the process along by asking its readers for suggestions on what sites ought to be included.

Some locations, such as the Trinity site in New Mexico where the first atomic bomb was tested, and the football field at the University of Chicago where the first sustained nuclear chain reaction was achieved, are already adequately commemorated. But many others have been totally ignored.

Suitable sites could range from laboratories, (whether at national labs, at universities or in industry) where important discoveries were made, to the childhood homes where well-known physicists grew up.

The resolution passed by the FHP reads, in part, "The Executive Committee of the Forum on History of Physics supports the proposal to place plaques at sites in the United States that have played major roles in the development of physics and physics-related projects, thereby honoring these sites and the physicists associated with them, while at the same time making these events part of the permanent record of major events in American history."

The resolution also notes that this project will tie in well with the projected World Year of Physics in 2005 (see IUPAP story above).

Key components of the project will be determination of the sites (in which FHP intends to participate), raising some funds for the plaques, and obtaining the permission of the current owners and/or occupants of the sites to install them.

To make it easy for APS readers to send in their suggestions, we have established a web site, **http://www.aps.org/apsnews/historicsites**, where people can register their choices. Updates on this process will be given periodically in *APS News*.

Solar Neutrinos, Latest RHIC Data Highlight DNP Meeting

The solution to the solar neutrino problem and new data from RHIC experiments were among the highlights of the 2002 fall meeting of the APS Division of Nuclear Physics, held October 9-12 at the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University in East Lansing, MI. The regular meeting was preceded by two all-day parallel workshops, one on the future of gamma-ray spectroscopy and the other on nuclear astrophysics at the limits of stability.

The so-called solar neutrino problem—that the measured flux of electron neutrinos is only about one-third as large as predicted by theory—has puzzled scientists for decades (see the Nobel Prize article on this page), but recent results from the Sudbury Neutrino Observatory (SNO) have demonstrated for the first time that the missing two-thirds of the predicted flux arrives at the detectors as mu and tau neutrinos. These results provide strong evidence for neutrino mass and mixing, according to Fermilab's John Beacom, and also have

See NEUTRINOS *on page 5*

APS Apker Award Honors Two Young Physicists

The APS has honored two budding young physicists with the 2003 Apker Award for their undegraduate thesis work.

Jason Alicea

Photo by: Lalena Lancaster

Jason Alicea of the University of Florida received the award for a PhD-granting institution for his thesis entitled, "Resistance of Multilayers with Long Length Scale Interfacial Roughness."

S. Charles Doret

Photo by: Lalena Lancaster

S. Charles Doret of Williams College received the award for a non-PhD-granting institution for his thesis entitled, "A Precise Measurement of the Stark Shift in the $6P_{1/2} \rightarrow 7S_{1/2}$ 378 nm Transition in Atomic Thallium."

Magnetic multilayers are mesoscopic structures composed of alternating ferromagnetic and paramagnetic layers. A theoretical understanding of the effects of interface roughness is essential for answering the question of what role the interface structure plays in determining the resistance and giant magnetoresistance of multilayers.

Researchers at the

See APKER *on page 7*

Nobel Prize in Physics Honors Astrophysics Pioneers

The 2002 Nobel Prize in Physics has been awarded to three physicists who have made pioneering contributions to astrophysics. Raymond Davis, Jr., a professor of physics and astronomy at the University of Pennsylvania, and Masatoshi Koshiba of the International Center for Elementary Particle Physics at the University of Tokyo in Japan, were honored "for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos." The other half of the prize went to Riccardo Giacconi of Associated Universities, Inc., in Washington, DC, "for pioneering contributions to astrophysics, which have led to the discovery of cosmic x-ray sources." The work of these three men led to the establishment of two new branches of astrophysics, those involving x-rays and neutrinos.

Neutrinos are important in astrophysics since they might have played a considerable role in shaping early galaxies; they are the form of energy coming directly from the solar core; and they account for the largest share of energy released during

See NOBEL PRIZE *on page 3*

Highlights

Members in the Media

"The goal is not for them to learn tons about astrophysics, but to introduce them to real science. They are amazed that this is what scientists do, and that I don't know how it's all going to come out."
—Glennys Farrar, NYU, on running an astrophysics boot camp for high school students, New York Times, November 5, 2002

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"This is sort of like creating a quark- gluon molasses, if you will. What has to go through is going to lose more energy as it comes out."
—Timothy Hallman, Brookhaven, on possible new evidence for the quark-gluon plasma at RHIC, Newsday, November 5, 2002

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"Our long-term goal is to try to look very precisely at this anti-atom, and by comparing the world's simplest antimatter atom and the world's simplest matter atom to make a very fundamental test of basic physics theories."
—Gerald Gabrielse, Harvard, on the first experiments with anti-hydrogen at CERN, BBC News, October 30, 2002

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"This is a grass-roots effort. What has happened is that, sort of spontaneously, the interested scientists in each of the regions have organized themselves to look at the scientific and technical challenges."
—Maury Tigner, Cornell, on the progress towards an international linear collider, San Jose Mercury News, October 29, 2002

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"The anthropic principle isn't as anthropic as people wanted."
—Gordon Kane, University of Michigan, in an article on cosmology in the New York Times, October 29, 2002

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"My main contribution is putting my money where my mouth is. My wife and I talked about it. We could buy a condo in Breckenridge, I suppose, but this is more important. This has the potential to transform how people learn science."
—Carl Wieman, University of Colorado, on donating most of his Nobel Prize money to a physics education project, Denver Post, October 29, 2002

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"With an ordinary newspaper, the headline is fixed by the editors before the paper is printed. With a quantum newspaper, the headline is not fixed until the first reader of the morning looks at the paper on the doorstep. Before that first reader looks at it, the headline is completely undetermined; but then what that first reader sees, every other reader will see, too."
—Seth Lloyd, MIT, on quantum entanglement, the Boston Globe, October 22, 2002

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"There seems no reason that self-consistent worlds with causal loops cannot exist. They don't defy logic, but only common sense."
—Todd Brun, Institute for Advanced Study, Dallas Morning News, October 21, 2002

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"It's ironic, but we want to go way underground to look at the cosmos. We can do things underground that we can't do on the surface or in space."
—Joe Dehmer, National Science Foundation, on plans for a National Underground Science Laboratory, Contra Costa Times, October 12, 2002

Bouncing Baseballs

Photo by Alan Chodos

The APS and the American Association of Physics Teachers (AAPT) helped sponsor the recent Discovery Channel Young Scientist Challenge. Middle school students around the country competed in science fair projects, and then finalists were invited to Washington to participate in team events. Seen here are the participants in the Baseball on the Mall challenge, in which five contestants performed measurements of how high a baseball bounces as a function of temperature. The APS presented them with souvenir copies of the volume "Physics in the 20th Century". The APS and AAPT also donated a number of $250 "Young Physicist Scholarships" that were awarded to members of the competing teams.

This Month in Physics History

December 14, 1989: Death of Andrei Sakharov

Andrei Sakharov was a Soviet scientist who started out as a weapons researcher and became, in the words of the Nobel Peace Committee, a "spokesman for the conscience of mankind."

A brilliant physicist who was fascinated by fundamental physics and cosmology, he first spent two decades designing nuclear weapons, becoming known as the father of the Soviet hydrogen bomb, contributing greatly to the military might of the USSR.

Gradually, however, he became one of the regime's most courageous critics, an internationally renowned defender of human rights and democracy.

Born in May 1921 into a Moscow family of cultured and liberal intelligentsia, Sakharov studied physics at Moscow State University and was quickly recognized as a brilliant student.

He was exempted from military service during World War II and completed his studies in 1942.

For several years he worked as an engineer at an armament factory, patenting several inventions, and when the war ended he was recruited into the top-secret nuclear weapons project.

In 1957, concerned about the radioactive hazards of nuclear testing, Sakharov wrote a pioneering article about the effects of low-level radiation, thus embarking on his long career of civic-minded dissent.

In 1964, he and 24 other prominent intellectuals and artists wrote to Brezhnev, warning the Soviet leader against the rehabilitation of Stalin, and in 1968 he emerged dramatically as an inspiration to the human-rights movement with an essay entitled, "Reflection on Progress, Co-existence and Intellectual Freedom," which was published in *The New York Times*. It was a scathing indictment of the Soviet totalitarian system, urged the end of the cold war, and set forth a constructive blueprint for remaking the Soviet Union and the world.

This was the first public appearance of the "Sakharov doctrine", espousing the indivisibility of human rights and international security. As a result, he was fired from the Soviet weapons program.

Sakharov's outspokenness also prompted a Soviet vilification campaign. Open letters were published denouncing him, some signed by members of the Soviet Academy of Science, in which he was branded "a Judas" and "laboratory rat of the West," among other epithets. Despite his frustration with attempting to influence the Soviet establishment from within, his advocacy of human rights and defense of prisoners of conscience earned him the Nobel Peace Prize in 1975.

The citation called him "the conscience of mankind" and said that he had "fought not only against the abuse of power and violations of human dignity in all its forms, but has in equal vigor fought for the ideal of a state founded on the principle of justice for all."

He was denied a visa to travel to Norway to accept the award; instead his wife, in Italy for eye surgery, accepted on his behalf.

In the years that followed, Sakharov continued to develop what would become the intellectual framework for the political, economic and legal reforms of perestroika, making forceful statements criticizing continued human rights violations and calling for the release of prisoners of conscience.

Although this won him international respect, Soviet authorities were losing patience. When he denounced the military intervention in Afghanistan in December of 1979, the Kremlin's response was quick. Not daring to arrest him, the Soviet Politburo instead detained him on the street on January 22, 1980, and forcibly banished him to Gorky, 250 miles east of Moscow.

He was never charged, tried before a court of law, or convicted. During his nearly seven-year exile, Sakharov received invaluable support from American physicists, who sent him reprints of their scientific articles and campaigned in the media in his defense.

He also worked on his autobiographical memoirs, which he had to rewrite three times to restore what was stolen by the KGB.

The dark clouds began to lift in December 1986, when Mikhail Gorbachev invited Sakharov to return to Moscow to perform "patriotic work." He was elected to the Presidium of the Academy of Science and to the Congress of People's Deputies, and was appointed a member of the government commission to draft a new Soviet Constitution.

In June 1989, at the First Congress of People's Deputies, Sakharov called for a radical reformation of the Soviet system and for an end to the Communist Party's dictatorship.

Just a few days before his death on December 14, 1989, he completed a draft of a new constitution for the "Union of Soviet Republics of Europe and Asia." He suffered a sudden heart attack while preparing for a contentious meeting the next day and told his wife, "Tomorrow will be a battle." Returning to check on him a short time later, she found his body.

Although he was a free man for less than three years following his exile, Sakharov lived long enough to see the totalitarian colossus begin to crumble.

He witnessed the fall of the Berlin wall and the beginning of irreversible changes that swept through Russia. He also saw his ideas, and steadfast dedication to truth and justice, shared by thousands of his fellow Russians.

For more information on the life and work of Andrei Sakharov, see the online exhibit by the American Institute of Physics, "Andrei Sakharov: Soviet Physics, Nuclear Weapons, and Human Rights." at http://www.aip.org/history/sakharov.

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Associate Editor .... **Jennifer Ouellette**
Special Publications Manager .... **Elizabeth Buchan-Higgins**
Design and Production .... **Stephanie Jankowski**
Forefronts Editor .... **Neville Connell**
Proofreader .... **Edward Lee**

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NUMBER NINE

Diffusion Limited Aggregation, A Kinetic Critical Phenomenon

T. A. Witten and L. M. Sander, Phys. Rev. Lett. 47 (1981) 1400), 2155 citations

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

When Tom Witten and Len Sander set out to model the growth of clusters in aerosols, one molecule at a time, they had no idea that the emerging patterns that appeared on their pen plotter would eventually ignite a flurry of activity in fields ranging from biology to astroscience. In the past twenty years, Diffusion Limited Aggregation (DLA) has helped to describe the origins of fractal patterns in electrodeposited metals, newly formed river basins, bacterial colonies, blood vessels in the eye, and the initial stages of urban sprawl, to name only a few applications.

As Sander explains it, the algorithms that lead to DLA are generally very simple. Imagine a single particle that serves a nucleation center. If another particle is released from some distant point, it meanders randomly through space, and it may either slip away to infinity or stick to the nucleation center. As subsequent particles wander by, they are more likely to stick to regions that protrude from the aggregate, leading to growing arms that creep forward and occasionally divide. In effect, the arms shield the inner portions of the aggregate, leaving the voids that characterize wispy fractal structures.

"We were doing a poor man's form of solidification," recalls Witten, "and we thought, on the one hand, that we were just going to end up with a solid lump of particles. On the other hand, we thought we had the elements that give you dendritic growth, and dendritic growth leads to these branching, treelike things that are not solid at all. We would have been prepared to see either thing, so we were very happy when it turned out to be tenuous."

Both Sander and Witten were surprised that their simple algorithm seemed to capture the essence of so many other phenomena. "Obviously," says Sander, "bacterial colonies, viscous liquids, and other systems have different origins. But the algorithms are basically the same, under the right circumstances."

Nevertheless, it took a few years before the importance of the DLA was widely realized. The initial hesitation to embrace DLA in other areas had to do in part with the deceptive simplicity of the algorithm. "When I would tell people about it," says Witten, "they would say 'Oh that's kind of interesting. Are you going to put it in a journal of mathematical physics?', or some other journal. They didn't realize that it was big deal."

Oddly enough, the fact that DLA-like growth is so ubiquitous in nature was also a hindrance to acknowledgment of the algorithm's importance. Sander points out that numerous researchers had come close to discovering DLA. "There were many people who just didn't know the implications of what they had," says Sander, "I attribute [our insight] to the fact that we were able to visualize the structure, and to Mandelbrot's work effectively saying 'You know, you really ought to think about shapes, and particularly about odd shapes.'"

By the mid 1980's, a flood of papers citing Witten and Sander started to appear in the literature as other researchers began to notice that DLA linked two emerging areas of research. "The reason this idea eventually struck lightning," Witten explains, "is that it connected two big things which people really didn't see how to connect before: dendritic growth on the one hand, and critical phenomena on the other hand. And they both need to be there for people to gloom onto it."

Although, the broad applicability and simplicity of DLA algorithms certainly help explain initial interest in the ideas of Witten and Sander, both researchers believe the challenge of finding an underlying theory is the likely reason that their paper continues to rack up citations. "I would have felt that it was amazing to hit on something that captured peoples' imagination even a tenth as much as this, and for it to keep going on is surprising," says Witten, "But I think what's truly unexpected is that it turned out to be one of these problems that just resists being solved. I would have thought would have been solved before 1990. That's really why I think it keeps going on."

Sander is confident that a workable theory will eventually emerge. "We should be able to reduce the problem to something less complex than the algorithm itself, "says Sander. "It should be possible to gain ideas about the overall behavior of DLA clusters without actually doing simulations. We think we've made a good deal of progress along those lines. Much remains to be done, but the sort of glimmerings of a real theory are now, I think, available."

Although Witten achieved a certain amount of renown, particularly in Europe, for his involvement with early DLA research, he has spent most of his time in the last two decades pursuing other subjects. As a professor of physics at the University of Chicago, he is currently concentrating on the study of granular materials and crumpling of polymer sheets.

Sander has been more or less involved in pursuing a theory of DLA for much of his career. In glancing at the collection of student theses on the bookshelf of his office in the University of Michigan physics department, Sander notes that few of the theses from the early 90's are related to DLA. The lull corresponds to a period that his own interest in the subject waned. At times, Sander says that he has felt about DLA the way that Arthur Conan Doyle felt about Sherlock Holmes—that is, Doyle sometimes wished he could kill off Holmes, but the popularity and success of the character forced him to continually revive the legendary detective.

How does Sander feel about DLA now? "Well, Sherlock Holmes is still alive," laughs Sander. "Seriously though, DLA is a nice picture, it sneaks up on you. When you look at it sort of cursorily, you can get a little bit bored. But when you start looking deep into it, it's pretty fascinating."

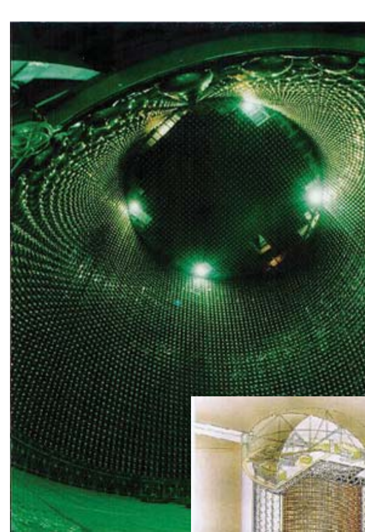
NOBEL PRIZE, *from page 1*

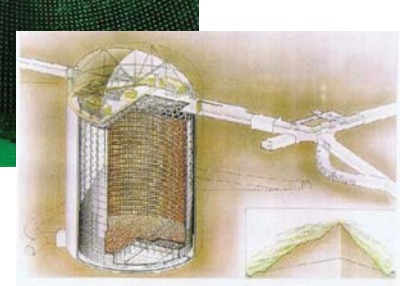
supernova explosions. The development of instruments to observe x-ray sources outside our solar system has led to many notable discoveries, including the detection of an x-ray background and the detection of x-rays from a variety of sources, such as comets, black holes, quasars, and neutron stars.

Neutrinos are formed in the fusion processes in the Sun and other stars when hydrogen is converted into helium, and they are difficult to detect because they hardly interact at all with matter. In the 1960s, Davis placed a tank filled with 615 tons of tetrachloroethylene, a common cleaning fluid, in a gold mine in South Dakota, with the expectation that every month approximately 20 neutrinos ought to react with the chlorine, evidenced by the creation of 20 argon atoms. The experiment gathered data until 1994, extracting about 2,000 argon atoms in all, much fewer than expected. One explanation for this discrepancy was that some electron neutrinos produced in solar fusion reactions convert into other neutrino species—specifically, muon and tau neutrinos—during the eight-minute flight from the solar core to Earth.

While Davis' experiment was running, Koshiba and his team constructed another detector, called Kamiokande, an enormous tank filled with water which he placed in a mine in Japan. When neutrinos passed through the tank, they interacted with atomic nuclei in the water, releasing an electrons and creating small flashes of light. The tank was surrounded by photomultipliers to capture the effect, and by adjusting the sensitivity of the detectors, the presence of neutrinos could be observed, and Davis' result was confirmed.

In order to increase sensitivity to cosmic neutrinos, Koshiba constructed a larger detector, Super-Kamiokande, which began operating in 1996. This experiment recently observed effects of neutrinos produced within the atmosphere, indicating a completely new phenomenon, neutrino oscillations, in which one kind of neutrino can change into another type. This finding implies that neutrinos have a nonzero mass. It could also explain why Davis did not detect as many neutrinos as he expected. Studies to confirm or disprove the neutrino oscillation theory are currently in progress at many laboratories around the world. Last spring, further proof of the oscillation principle was reported by scientists at the Sudbury Neutrino Observatory who found that all solar neutrinos (albeit not the same mix of species as was produced in the Sun) were accounted for.





Located in Japan, Super-Kamiokande is a detector that studies the elisive particles known as nertrinos. This is a picture of the detector wall and top with about 9000 photomultiplier tubes which help detect the neutrinos.

The Sun and all other stars emit electromagnetic radiation at different wavelengths, including visible and invisible light, and x-rays, but in order to investigate cosmic x-ray radiation, it is necessary to place instruments in space. The first extraterrestrial x-ray radiation was recorded in 1949 by instruments placed on a rocket.

In 1959 Giacconi constructed the first x-ray telescope, which collected radiation with cone-shaped, curved mirrors onto which the x-rays tell very obliquely and were totally reflected. He and his group also carried out rocket experiments to try to prove the presence of x-ray radiation from the universe. In a seminal experiment, a rocket flew at high altitude for six minutes, detecting no radiation from the moon. A surprisingly strong source at a greater distance was recorded, since the rocket was rotating and its detectors swept the sky. In addition, a background of x-ray radiation was discovered evenly distributed across the sky.

These unexpected discoveries led to the rise of x-ray astronomy, and subsequent improvements to the instruments allowed scientists to determine the direction of the radiation, and to identify sources. The source discovered in the first successful experiment was a distant ultraviolet star in the Scorpio constellation. Other important sources were stars in the Swan constellation. However, it was difficult to carry out these studies because the possible observation times from the balloons and rockets were too short.

To extend observation times, Giacconi constructed a new satellite, UHURU (meaning "freedom" in Swahili), launched in 1970 from a base in Kenya, that was ten times more sensitive that the rocket experiments. Every week it was in orbit produced more results than all previous experiments combined. He also constructed a high-definition X-ray telescope in 1978, which was able to provide relatively sharp images of astronomical objects the universe at x-ray wavelengths.

Yet Giacconi wanted to build an improved, even larger X-ray observatory. The effort took more than 20 years, but in 1999 the Chandra telescope was launched. The instrument has provided extraordinarily detailed images of celestial bodies in x-ray radiation. Thanks to Giacconi's pioneering contributions, a new, fantastic zoo of important and strange celestial bodies has been discovered and studied.

LETTERS

How Planck found the Quantum

Your October 2002 article in "This Month in Physics History" gives an excellent account of how Planck obtained his famous formula for black-body radiation by fitting experimental data to an expression based on entropy arguments. But like many other accounts on this subject, this article does not offer even a clue as to how Planck came upon the idea of introducing the concept of energy quanta to justify his empirical formula. Did Planck make this revolutionary discovery by just "fiddling around", as Feynman tells the story, or by "divine" madness, according to Abraham Pais?

Actually, the answer can be found from a reference in his December 14, 1900 paper where he first announced his quantum hypothesis. There Planck cited Boltzmann's 1877 paper on the relation between entropy and probability. To illustrate this relation, which involves counting the number of configurations of a system, Boltzmann had introduced a one dimensional molecular gas with discrete energies defined by integer multiples of a fundamental element of magnitude ε. Planck simply took over Boltzmann's fictitious "quantum" model by substituting for these molecules the resonators of frequency ν which he had introduced in his previous treatment of black-body radiation, and setting $\varepsilon = h\nu$, where h is a constant.

Of course, in the next section of his paper Boltzmann took the limit that ε vanishes, as demanded by classical physics. But Planck ignored this step, because he had succeeded in providing a derivation for his black-body formula by keeping ε finite. Perhaps he did not bother to read this section of Boltzmann's paper. This reference also explains why Planck, after struggling for several years with the theory of black body radiation, took only a few weeks to introduce his quantum hypothesis, "conflicting with all past physical theory".

Michael Nauenberg
Santa Cruz, California

Planck Discovered Boltzmann's Constant

In the October "This Month in Physics History", Max Planck's formula for black body radiation was featured. Although the author says that Planck "made no other significant discoveries of comparable importance to his 1900 work," he presents only part of the significant discovery. Besides the constant h, Planck also discovered the constant k, known today as the "Boltzmann constant." The values he calculated were amazingly close to the present day values.

At the presentation of the Nobel Prize in Stockholm in June 1920, Planck commented that to his knowledge, Boltzmann never realized that k had a unique value; he never even thought of a possible measurement of such a constant. This discovery of k should rank as a major discovery in physics, although it was a by-product of the derivation of the radiation theory, published in the same paper.

Henn H. Soonpaa
Grand Forks, North Dakota

In Defense of Rare Earth Metals

I would like to respond to the article by Martin Bridge in the October issue of *APS News*. I agree with the author that we should verify the discovery of new elements. Likewise, we should verify that of new compounds and chemicals that claim to have special properties.

However, the author goes on to suggest that many of the rare earth metals are not new elements, but just "copycats" of other elements, or possibly some exotic carbon structures. This is a very misleading idea. If several of the rare earth metals are "copycats," then why does x-ray diffraction reveal that many of these elements exist in different structures at ambient conditions? Other properties of rare earth metals have also been examined in great detail to show their distinct differences.

Finally, the author claims that "Nobody will really miss them." REMs are used to enhance the properties of iron and other metals to increase their strength and operating life. They are used in glassmaking, ceramic glazes, glass-polishing abrasives, catalysts for petroleum refining, lasers, and color-television picture tube phosphors, among other applications. So maybe we would miss them.

Gary Chesnut
Los Alamos, New Mexico

Not Convinced that Silicon Doesn't Exist

I find it difficult to give Martin Bridge's article, "Investigation Pokes Holes in the Periodic Table," (*APS News*, October 2002) much credibility when he seems to quote for the most part those who do not wish to be identified. I would like to see the evidence that silicon does not exist. Failure to quote sources is hardly the scientific method.

Clarence Cunningham
Stillwater, Oklahoma

Ed. Note: *Martin Bridge's article appeared under the banner "Zero Gravity: the Lighter Side of Science". It was not meant to imply that the existence of any chemical elements other than 118 and 116 had actually been called into question.* APS News *regrets any confusion that may inadvertently have arisen.*

Fraud Not A Subject for Humor

With regard to the October 2002 Zero Gravity Column in *APS News*, it's hard for me to imagine something that stems from the falsification of data in relation to the claimed discovery of elements 118 and 116 as being related to "The Lighter Side of Science".

Related to Enron, Arthur Andersen and all the present day failures of personal and institutional ethics, yes. Relating to a tragedy for individuals and for the profession, certainly. But hardly a subject for humor.

David J. Ritchie
Naperville, Illinois

Viewpoint...

Where have all the graduate students gone?

By Michelle Thaller

Is it just me, or are things getting kind of quiet around here? For several years now, a complaint has been heard in the hallways of our top universities: where have all the graduate students gone? Every year, there seem to be fewer and fewer qualified students applying for positions in science and engineering doctoral programs.

The problem is far from anecdotal. Now, with statistics compiled by the National Science Foundation, professional science organizations, and the federal government, it's official. Prospective students are turning away from careers in science. Since a peak in the early 1990s, the number of science and engineering students has tanked. In some fields, the decrease has been as much as 5% per year, according to an NSF study. In electrical engineering, enrollments have dropped nearly 30% in the last 10 years. Overall, the number of Ph.D. students in science and engineering is at a 40-year low, and there is little sign of a turnaround.

This trend has sent academic departments and education experts scurrying. Graduate students are the lifeblood of research universities, working in the trenches to produce the discoveries that lead to publications, as well as shouldering much of the teaching load. The top dozen or so American universities may have to admit students they don't feel are up to their standards, but for other universities, the problem is far more acute.

Many physics and engineering departments are coming under increasing pressure from their university management. How do you justify having a PhD—granting physics department, when there are no students to grant the degrees to? Some departments may be forced to disband, or combine their resources with other departments. Outside of traditional academia, even businesses and government agencies are getting a little nervous. At a recent NASA education meeting, Dr. Edward Weiler, assistant administrator of NASA, sounded an alarm in his keynote address. Who, he asked, will be the next generation of NASA scientists and engineers, if students continue to turn away from science?

As with most problems, there isn't just one reason for the dearth of young scientists. And some components of the problem are even encouraging, when viewed from a more global perspective. One interesting note is that the enrollment of "traditional" science students (white males) has been declining for a long time, much longer than the last 10 years, according to the NSF study. But the overall number of graduate students remained unchanged, due to increased numbers of both female and foreign students.

Enrollment of foreign students, in particular, ballooned in the '80s and '90s. Many of these students ended up settling permanently in the US, but statistically, about half returned to their home countries. These top-ranked scientists then set up university departments of their own, and continued collaborating with their US colleagues. Now, for the first time in decades, foreign enrollment in American science programs is actually declining. That's probably good for global well-being, but it also means that an important source of science students (as well as American-immigrant scientists) is drying up.

What else is influencing the decline in science students? When I put the question to my colleagues, they were quick to blame the changing job environment. A few generations ago, being a professor or an engineer was a much more lucrative career choice. That isn't the case anymore. Scientists are paid well, but hardly opulently. And there's an increasing under-class of scientists that are paid appallingly. After graduate school, most scientists enter a post-doctoral research fellowship. This sort of fellowship allows them to do research at a university for a limited amount of time, usually three to five years.

Post-docs have some advantages. There are minimal teaching and administrative duties. That allows for lots of research time, a perfect way to publish papers, pad the resume, and get on the path to a permanent job. But there are far more post-docs working at universities than there are permanent jobs for them to move into. When one post-doc is up, it's much easier to find another post-doc position than a professorship. That means you need to pick up and move to another university, something that gets increasingly difficult as people settle down and start families. You also have to put up with getting paid a pittance, not all that much more than a graduate students stipend. After a few rounds of this, many young scientists start to get bitter.

In the last few generations, everyone has had to deal with downsizing their career expectations. Scientists are no worse off than any other group, and realistically, being a scientist is still a comparatively low-stress, high-pay career. And a big part of the problem is that so few American students know that. It's time to face the fact that we, the scientific community, have a lot to answer for. Who's discouraging the students from choosing science? We are.

Of course science can be difficult. It may take years to learn quantum mechanics, but it also takes years to become proficient at speaking French. And yes, becoming a world-class physics professor is highly competitive, and usually involves a lot of nasty politics. But there are hundreds of other good science jobs to be had that are more collegial and better suited to different personalities. I'm not one of those rabidly competitive, top-ranked scientists, but I have a good job that pays well and gives me plenty of professional fulfillment. And somehow this view of science is getting lost.

It's time to stop weeding out good prospective scientists. The world of science is much broader and diverse than traditional academia will admit, and a career in science is more attractive than most people suspect. And we, as scientists, could be a bit more encouraging about it.

Michelle Thaller is a Caltech astronomer with a special involvement in education and public outreach. This article originally appeared in the Christian Science Monitor *on July 15, 2002. Reprinted with permission.*

MARCH MEETING *from page 1*

There will also be numerous nontechnical sessions on physics and society, history of physics, international physics, education, and graduate student affairs.

Once again, the Society will be organizing a host of special events, including receptions, alumni reunions, and a students' lunch with the experts. There will also be a three-day job fair from Monday through Wednesday to facilitate communication between employers and potential employees.

Rounding out the program will be a larger and enhanced exhibit show featuring vendors displaying the latest products, instruments and equipment, and computer software, as well as scientific publications related to physics research and applications.

On the Sunday before the meeting a special workshop on detecting bioterrorism threats will take place. In addition, there will be eight half-day tutorials, and the APS Division of Polymer Physics will be holding its annual two-day short course that weekend, as well. The theme is polymer chemistry for physicists, with a focus on major preparative routes to model polymeric materials, as well as the range of materials accessible by a variety of polymerization techniques.

The preparation of macromolecules with controlled molecular weights, narrow molecular weight distributions, specific comonomer sequences and precise architectures is of critical importance to polymer physics, and the course is intended to be useful to both academic and industrial scientists with an interest in polymer science and engineering.

Give Credit Where Credit is Due

The response of the APS via its public affairs panel to the two recent scandals is a little like somebody asking CEOs after the recent corporate scandals to be "nice". Authorship guidelines in any science and in physics in particular are by design unenforceable. The

See LETTERS on page 6

zero gravity
The Lighter Side of Science

The 2002 Ig Nobel Prizes

The 2002 Ig Nobel Prizes, presented for achievements that "cannot or should not be reproduced," were awarded at Harvard's historic Sanders Theatre in early October before 1200 spectators in a ceremony filled with lab coats, opera singers, paper airplanes, and a barking dog.

Seven of the ten new winners journeyed to Harvard—at their own expense—to accept their Prizes.

The event was produced by the science humor magazine "*Annals of Improbable Research*" (AIR), and co-sponsored by the Harvard Computer Society, the Harvard-Radcliffe Science Fiction Association and the Harvard-Radcliffe Society of Physics Students.

The evening also featured numerous tributes to the evening's theme of "Jargon." Foremost were the 24/7 Seminars—lectures in which famous scientists explained their field of research, first in twenty-four (24) seconds, and then in seven (7) words.

The night also featured the premiere of a new mini-opera called "The Jargon Opera," which starred professional opera singers and the Nobel Laureates, and a pre-ceremony concert by the Brechtian-punk-physics band The Dresden Dolls.

Marc Abrahams, master of ceremonies (and editor of the *Annals of Improbable Research*) closed the ceremony with the traditional, "If you didn't win an Ig Nobel prize tonight—and especially if you did—better luck next year."

For more information, see www.improbable.com

And the winners are:

BIOLOGY. Norma E. Bubier, Charles G.M. Paxton, Phil Bowers, and D. Charles Deeming of the United Kingdom, for their report "Courtship Behaviour of Ostriches Towards Humans Under Farming Conditions in Britain."

PHYSICS. Arnd Leike of the University of Munich, for demonstrating that beer froth obeys the mathematical Law of Exponential Decay.

INTERDISCIPLINARY RESEARCH. Karl Kruszelnicki of The University of Sydney, for performing a comprehensive survey of human belly button lint —who gets it, when, what color, and how much.

CHEMISTRY. Theo Gray of Wolfram Research, in Champaign, Illinois, for gathering many elements of the periodic table, and assembling them into the form of a four-legged periodic table.

MATHEMATICS. K.P. Sreekumar and the late G. Nirmalan of Kerala Agricultural University, India, for their analytical report "Estimation of the Total Surface Area in Indian Elephants."

LITERATURE. Vicki L. Silvers of the University of Nevada-Reno and David S. Kreiner of Missouri State University, for their colorful report "The Effects of Pre-Existing Inappropriate Highlighting on Reading Comprehension."

PEACE. Keita Sato, President of Takara Co., Dr. Matsumi Suzuki, President of Japan Acoustic Lab, and Dr. Norio Kogure, Executive Director, Kogure Veterinary Hospital, for promoting peace and harmony between the species by inventing Bow-Lingual, a computer-based automatic dog-to-human language translation device.

HYGIENE. Eduardo Segura, of Lavakan de Aste, in Tarragona, Spain, for inventing a washing machine for cats and dogs.

ECONOMICS. The executives, corporate directors, and auditors of Enron, Lernaut & Hausbie [Belgium], Adelphia, Bank of Commerce and Credit International [Pakistan], Cendant, CMS Energy, Duke Energy, Dynegy, Gazprom [Russia], Global Crossing, HIH Insurance [Australia], Informix, Kmart, Maxwell Communications [UK], McKessonHBOC, Merrill Lynch, Merck, Peregrine Systems, Qwest Communications, Reliant Resources, Rent-Way, Rite Aid, Sunbeam, Tyco, Waste Management, WorldCom, Xerox, and Arthur Andersen, for adapting the mathematical concept of imaginary numbers for use in the business world. *[NOTE: all companies are US-based unless otherwise noted]*.

MEDICINE. Chris McManus of University College London, for his excruciatingly balanced report, "Scrotal Asymmetry in Man and in Ancient Sculpture."

Wiseman Reflects on Fellowship Year on the Hill

Organizing committee hearings, working on legislation to increase federal funding for science, and maintaining business as usual in the midst of increased security concerns were just a few of the issues facing Jennifer Wiseman, the 2002 APS Congressional Fellow. Wiseman spent this past year in Washington, DC, working as a staff member for the House Science Committee.

Wiseman received her BS in physics from the Massachusetts Institute of Technology in 1987 and while still an undergraduate had the distinction of co-discovering a comet later named Comet Wiseman-Schiff, after Wiseman and her collaborator, astronomer Brian Schiff. After that initial success, she went on to graduate school, earning her PhD in astronomy from Harvard University in 1995, with a thesis entitled "Large Scale Structure, Kinematics, and Heating of the Orion Ridge." She then served three years as a Jansky Fellow at the National Radio Astronomy Observatory before taking on a Hubble fellowship at Johns Hopkins University in Baltimore, MD. At JHU, she studied regions of star formation, specifically the conditions of interstellar gas clouds that lead to the birth of new stars.

Although satisfied with her research career, Wiseman applied for the APS Congressional Fellowship to foster a parallel interest in integrating science into the broader context of public service. She has long been active in public outreach, giving astronomy lectures to elementary, middle and high school students and to general adult audiences since 1993. And spending a year as a congressional fellow gave her the opportunity to have a concrete impact on issues of concern to her.


JORDAN RADDICK/APS
Jennifer Wiseman

Her year on the Hill had a rocky start. Shortly after the terrorist attacks of September 11th, 2001 rocked the nation, a series of random anthrax outbreaks caused Congress to shut down many of its offices, just as Wiseman and Congressional fellows from other scientific societies were in the process of selecting where they would like to work. She still managed to interview with several offices, and wound up choosing to work on the staff of the House Science Committee. "I felt it was the best opportunity to give me a chance to play a part in a very broad range of science policy issues," she says.

Wiseman worked primarily for two subcommittees. The Subcommittee on Space Aeronautics has jurisdictional oversight over NASA, and Wiseman served as the main contact for issues relating to space science and earth science at the agency. She was also the main contact for issues at the National Science Foundation dealing with physics and astrophysics through her work on the Subcommittee on Research, which has jurisdiction over the NSF. Her responsibilities included organizing Congressional hearings on specific issues and working on science-related legislation, such as H.R. 4664, the NSF reauthorization bill which would put the agency on a track to double its budget over the next five years.

Among the highlights of Wiseman's fellowship experience was putting together a Congressional hearing on science prioritization at NASA. She also had the opportunity to witness first-hand a major reshuffling of the federal government as Congress wrestled with the creation of a Department of Homeland Defense, which will incorporate several areas of jurisdiction formerly under the oversight of other departments and committees. The House Science Committee recommended that the new department appoint

See **WISEMAN** *on page 7*

NEUTRINOS *from page 1*

far-reaching implications, from the solar core temperature to models of neutrino mass to the lepton number of the universe. The upcoming low-energy solar neutrino experiments and the KamLAND reactor antineutrino experiment in Japan will play a very important role in exploring the remaining unresolved questions surrounding solar neutrinos.

John Harris of Yale University reported on new results on collisions of ultra-relativistic heavy nuclei at RHIC, in which nuclear matter is compressed and heated to energy densities where it is predicted to melt into a plasma of deconfined quarks and gluons. In his talk, Harris focused on new evidence for hard scattering, as well as jet quenching as a tool to probe the quagmire and understand its properties.

Another RHIC researcher, Brookhaven's Julia Velkovska, reported the first evidence for high-transverse-momentum (p_T) suppression of pions and inclusive hadrons discovered in central Au+Au collisions at the facility. Unexpectedly, protons and antiprotons remain unsuppressed and exceed the pion yields. Velkovska described one possible explanation that strong radial expansion in the system boosts the transverse momenta of heavier particles into the high p_T region.

Argonne National Laboratory's John Arrington addressed the question of whether ordinary nuclei contain exotic states of matter. Recent data from experiments at Jefferson Laboratory have enabled Arrington's group to begin to map out the strength of two-nucleon correlations in nuclei, and he believes that upcoming experiments should enable them to isolate the presence of multi-nucleon correlations. Such correlations help describe nuclear structure and represent high-density "droplets" of hadronic matter. While there have been hints of non-hadronic structure in nuclei, Arrington believes that future measurements will enable them to measure directly the quark distributions of high-density configurations in nuclei. A modified quark structure in these close-packed nucleons would provide a clear signature of exotic components to the structure of nuclei.

The advent of a new generation of radioactive beam facilities, as well as advances in the theoretical understanding of unstable nuclei, has enabled scientists to begin to delineate the nuclear processes that govern such stellar explosions as supernovae, novae and x-ray bursts, which are closely related to fundamental questions regarding the origin and fate of the elements. NSCL's Hendrik Schatz described recent calculations on the rp process and neutron star crust processes, and also summarized experimental data from NSCL and the GSI facility in Darmstadt, Germany.

Getting Fruitcake Off the Shelf With Basic Physics

It's the perennial butt of jokes during the holiday season, but people keep giving it nonetheless. And now it seems that there may be hope for that holiday fruitcake after all. Peter Barham, a University of Bristol physicist and author of *The Science of Cooking*, says that by using a little chemistry and physics, even a stale fruitcake that's been sitting for years can be revived, and it may be better than ever.

"The reason fruitcake, or any cake for that matter, goes stale is because it appears to lose its moisture," says Barham. But the moisture isn't really lost; the starch in the cake has simply absorbed it. The problem, Barham explains, is that the molecules in the starch (flour) are trying to get back to the ordered form they had when they were wheat. But since the starch can't make that transformation, it does the next best thing by hijacking the water from the cake to form small crystals. With all the water caught up by these starch molecules, the cake tastes dry, and is tougher to digest.

But Barham says a little physics can solve the problem. "You just need to melt the starch crystals," he says, which can be done by heating the cake. He suggests wrapping the cake in aluminum foil to prevent any moisture from escaping, and slowly warming the cake in a 130 degree oven before serving. "This will melt the crystals, release the water, and refreshen the cake." Once the cake starts to cool, however, the drying process will begin again.

But what about the taste? Barham contends that fruitcakes actually get better the longer they sit. "The dried fruits in the cake can actually age," he says, "much like wine ages over time." The tannins present in the fruit seep into the cake, changing chemically to create intense and distinct flavor compounds. The longer the cake sits, he says, the more varied and intense the flavors become. In fact, if you're looking to bake a fruitcake this year, it's probably too late; it won't have time to age. But the one Aunt Maude gave you last year might do nicely.

— *Inside Science News Service*

Focus on Committees

Committee Helps APS Manage Member Needs

Managing the needs of more than 42,000 members is a major undertaking, and the APS has a Committee on Membership to provide advice and oversight for the Department of Membership staff. The Committee examines issues such as membership dues and recruitment, reviews membership benefits, and conducts member surveys. Lately, the Committee has added a special emphasis to improving its communication with members from industry.

"The Membership Committee deals primarily with two things that are somewhat conflicting," says Committee chair Bill Cummings, an industrial physicist at Iridigm Display Corporation in San Francisco. "One is to maintain a good and vibrant membership. The other is to make sure the services provided by membership are the ones needed by members."

Assuring that benefits are valuable to all members can be a challenge. APS membership is surprisingly diverse, as the Society draws its members from all areas of physics. According to a 2001 survey by the American Institute of Physics (AIP), 76% of APS members identify themselves as physicists, 11% as engineers, and six percent as chemists. Half work in a university or academic setting, one quarter in industry, and the remaining quarter in government.

To attract industrial physicists to the APS, the Committee is considering a half-price membership promotion at the end of this year. During the promotion, physicists in industry who have never been members will be allowed to sign up for membership at the discounted rate.

Industrial physicists make up about a quarter of APS membership, but this represents less than half of all industrial physicists. Many more belong to other professional societies, such as the Institute of Electrical and Electronics Engineers (IEEE) or the American Chemical Society (ACS). But the Membership Committee thinks industrial, academic and government physicists can benefit from sharing their ideas and research through the APS.

Bill Cummings

"It's good to maintain dialogue between the different kinds of physicists," says Cummings, "because some research gets done in industry that doesn't get done in academia, and some research gets done in academia that doesn't get done in industry. Also, it's good for academics to have contacts in industrial physics so that they can pass them along to their students going into industry."

Another perennial issue for the Committee is membership dues. Every year, they examine fees, determine whether or not they should be raised, and issue advice to the APS Council. The Committee says it doesn't want fees to rise uncontrollably, but stresses that the APS needs membership dues to cover some of the costs of servicing its members.

"We want to provide the best balance between the benefits members get by joining the APS, and what they pay," says Trish Lettieri, the APS Director of Membership and staff liaison for the Committee.

On January 1, 2003, membership fees will increase by $2 to $102. Senior, Junior and Student dues will all increase by $1 as well. The increase, says Lettieri, was recommended by the Committee and is in line with the increase in cost of living.

"In the future, we're going to look at adjusting dues a little bit each year to match inflation," she says, "to avoid the big jumps we've had in the past."

To help foster membership growth, the Committee also runs promotions such as last year's half-price membership campaign. During the last promotion period, the APS signed on almost 1,000 new and reinstated members. The Committee hopes to run these membership drives occasionally in future years.

Since many APS members join as students, the Committee focuses on ways to retain these student members. They initiated a new "student get a student" promotion on September 1, which encourages current student members to recruit fellow physics and related science students. The new recruits will still get their first year's membership free, and the members who recruited them will be entered in a drawing to win one of five $200 gift certificates to Amazon.com. The promotion will run until the end of this year, with the goal of adding 1,000 new student members.

"We're always working to increase the number of members in the Society," says Lettieri, "but we put equal effort into trying to maintain the ones we have. That is a big focus for the Committee; to look at the benefits of membership, and make sure it's worthwhile for everyone."

While continuing to increase membership is always a priority for the Committee, they do not let that goal overshadow the needs of the current membership.

"I think that the primary advantage of having more industrial physicists, for example, is to provide a unified front in supporting government funding of research," says Cummings. "The benefits aren't restricted to academic physicists. All the successful industrial physicists who are out there had their research as graduate students supported almost exclusively by the government. Now, they're contributing to the economy because of that. It's a very powerful argument when lobbying to maintain that support."

—Desirée Scorcia

New Nanotechnology Bill Introduced

A bill (S. 2945) that would expand on the current National Nanotechnology Initiative (NNI) was passed unanimously by the Senate Commerce, Science and Transportation Committee on September 19, only two days after its introduction by Senator Ron Wyden (D-OR).

A September 17 hearing by Wyden's Science, Technology, and Space Subcommittee generated plaudits for the existing national program and support for Wyden's bill, but also voiced concerns about relations between industry and universities and the effect on transferring government-funded research to the marketplace. The current multi-agency NNI program was established by President Clinton in FY 2000.

S. 2945 would enhance the coordination, funding, and management of federal nanotechnology R&D. It would authorize establishment of a presidential advisory panel, a national coordinating office, and a biennial National Research Council (NRC) survey of international progress in the field, and would support long-term research, interdisciplinary research centers and infrastructure, transfer of technology to industry and greater consideration of the societal, ethical, education and workforce issues related to nanotechnology.

The bill is cosponsored by Senators George Allen (R-VA), Mary Landrieu (D-LA), Joseph Lieberman (D-CT), Hillary Clinton (D-NY) and Barbara Mikulski (D-MD). No companion bill for S. 2945 has yet been introduced in the House.

— Audrey T. Leath, AIP

LETTERS, *from page 4*

authorship ethical guideline of the APS, compared to its biomedical sisters, is so ill defined that physicists themselves cannot agree on what it means, so ill marketed that 74% of junior physicists claim not to have seen them and 92% of APS members claim not to use them.

Inappropriate coauthorship is common among physicists. Public research monies have an extra tax added that moves money from those physicists who did the research to those physicists who pretend they did. If the APS wants to clamp down on inappropriate coauthorship, we can. We can decide to give back to the individual the incentive to do work, to reward creativity and not politics. We can decided to give credit where credit is due. But I guess we won't.

Eugen Tarnow
Riverdale, New York

MEETING BRIEFS

• **Four Corners Section, October 4-5 2002.** The APS Four Corners Section held its annual fall meeting at the University of Utah in Salt Lake City. Friday afternoon's speakers gave presentations on compact soft x-ray lasers, manipulating single electrons at the surface of silicon dioxide, and thermodynamics of URu_2Si_2. The banquet on Friday evening featured a keynote address by Nagin Cox of the Jet Propulsion Laboratory on the Galileo mission to Jupiter. Saturday afternoon featured two sessions on physics research in the Four Corners region, which encompasses Arizona, Colorado, New Mexico and Utah. Topics included the use of SQUID sensors in both biological and non-biological applications, challenges in regional physics education, measuring ultra-high-energy cosmic rays, and nanothermodynamics in condensed matter. Also on Saturday was a grad student pizza forum on conducting graduate thesis research at the DOE national laboratories, and a memorial session on the history of cosmic ray research in Utah.

• **Texas Section, October 10-12 2002.** The APS Texas Section held its annual meeting at the University of Texas at Brownsville and the Texas Southmost College, both in Brownsville, TX. Invited plenary lectures covered a broad range of topics, including QCD, strings and black holes; recent results in solar neutrino physics; charmed baryon spectroscopy at CLEO; photonic crystal nanostructures and left-handed materials; grids for data intensive science; and the search for gravitational waves using LIGO. Friday evening's banquet speaker was Ramon Lopez of the University of Texas at El Paso, and former director of education and outreach for the APS, who spoke about the current state in physics education. Along with the APS program, the AAPT offered several workshops for teachers.

• **New York Section, October 11-12 2002**. The APS New York Section held its annual fall meeting at Syracuse University on the topic of new horizons in gravity and astrophysics. Experts in the field discussed new developments in gravitational physics and astrophysics in presentations designed to be tutorial in nature and aimed at a general interest level. Topics covered included the search for gravitation waves; particle cosmology; extra dimensions; microquasars; the search for dark matter; detecting the cosmic microwave background radiation; astrochemistry; and matter and radiation in superstrong magnetic fields. Friday evening's banquet speaker was Sean Carroll, a professor of the University of Chicago, who spoke on the possibilities for dark energy, providing an overview of theoretical proposals and a summary of the observation constraints which any model must satisfy.

• **Ohio Section, October 18-19 2002.** The APS Ohio Section held its annual fall meeting at the Ohio State University in Columbus. The sessions on Friday featured talks on such subjects as recent results from the Cryogenic Dark Matter Search project, surface photovoltage spectroscopy of single crystal zinc oxide, and two talks on the development of detectors for, and Monte Carlo simulation of, Compton cameras, a novel device for medical imaging. Friday evening's banquet speaker, Sydney Meskov, spoke on large gravity wave detectors. One Saturday morning session focused on string theory, including such topics as the production of black holes by cosmic rays; mass, inertia and geometry; and using flat-spacetime estimators to estimate the manifold dimension of causal sets that can be embedded into curved spacetimes.

• **New England Section, October 25-26 2002.** The APS New England Section held its annual fall meeting at Bridgewater State College in Bridgewater, MA, a regional comprehensive public college. Speakers at the invited sessions spoke on such topics as the dynamics of star formation; the scale of the universe before parallax; solar variability and climate change; and the development of tabletop probes for TeV physics. Because the meeting was held jointly with the AAPT, there was an increased number of workshops on physics teaching, as well as a panel discussion for new teachers and a session devoted to favorite labs and classroom demonstrations. There were also two banquets on Friday and Saturday night. The keynote speakers, respectively, were Neil de Grasse Tyson, director of the Hayden Planetarium in New York City, who discussed recent controversy over the classification of Pluto in the solar system; and Paul Hewitt, author of several textbooks and the popular "Hewitt Drewit" column in *The Physics Teacher*, who gave a talk on teaching physics as a study of nature's rules to make it relevant to general audiences.

• **Southeastern Section 2002, October 31-November 2 2002.** Finally, the APS Southeastern Section held its annual fall meeting at Auburn University in Auburn, Alabama. The three-day technical program included invited sessions on plasma physics, materials science, astronomy and astrophysics, atomic physics, nuclear physics and biophysics. Friday afternoon featured a session on teaching and outreach, detailing several educational programs in the region, and the evening banquet featured a keynote address by popular science writer Hans Christian von Baeyer of the College of William and Mary. There were also two sessions on present and future user facilities at Oak Ridge National Laboratory, including planned upgrades to CEBAF and the Holifield Radioactive Ion Beam Facility, as well as the Spallation Neutron Source currently under construction, and the planned Center for Nanophase Materials Science, which will integrate nanoscale research with neutron science, synthesis science and theory, modeling and simulation. The center will begin construction next year and is slated to begin operating in late 2004.

ANNOUNCEMENTS

Now Appearing in RMP
Recently Posted Reviews and Colloquia

You will find the following in the online edition of Reviews of Modern Physics October, 2002, at http://rmp.aps.org.
George Bertsch, Editor.

The geometry of soft materials: a primer
—Randal Kamien
Much of the theory of soft matter involves the statistical physics of curves and surfaces—e.g., polymers and membranes—and the appropriate language to describe these conformations is that of differential geometry. Differential geometry is a bridge between physical shapes and analytical mathematics, and this review is an introduction to the field using myriad examples from soft condensed-matter physics.

Also Newly Posted:
Colloquium: Laboratory experiments on hydromagnetic dynamos
—Agris Gailitis, Olgerts Lielausis, Ernests Platacis, Gunter Gerbeth, and *Frank Stefani.*

ATTENTION

APS STUDENT MEMBERS!

The 2002 APS Student-Get-A-Student Campaign is in full swing. Ask your colleagues enrolled in a Physics or Science related program to join APS.

From now until the end of 2002, each time you recruit a new student member, you'll be entered into a raffle to win a $200 gift certificate from Amazon.com.*

For more information, go to www.aps.org/memb/sgas.html.

*Five winners will be chosen at random.
One prize per recruiter.

Signatures Sought for Quantum Physics Topical Group

NOTE: This announcement was printed as a letter in the October issue of APS News. Unfortunately, the URL that is given in the text was not active when the letter came out. This problem has been fixed, so anyone wishing to visit the web site and sign the petition can now do so.

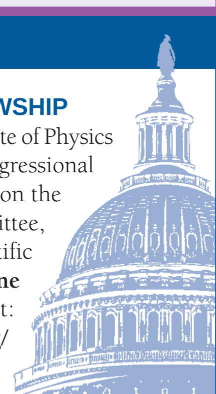
We are trying to start a topical group of the APS on quantum physics. Those of us who work on quantum information, including cryptography, and classifying entangled states in varying ways, and quantum computation, and all sorts of fundamental problems in quantum theory-measurement theory, superposition, Bell Theorems, etc., have no natural home in the APS. Many of the current APS units are relevant for some of our interests, but none are devoted specifically to our primary interests.

We would appreciate the signatures of everyone who works in these areas, and hope that everyone will publicize this to their friends in the field. The whole petition, which spells out the complete rationale, can be read and signed at the website: http://www.sci.ccny.cuny.edu/~greenbgr/

Daniel Greenberger, New York, NY
Anton Zeilinger, Vienna, Austria

ERRATUM: *The Back Page by Colin Powell in the October issue of APS News was taken from a speech that Secretary Powell delivered at the National Academy of Sciences on April 30, 2002 . This information was inadvertently not included in the print version, and APS News regrets this omission.*

FELLOWSHIP PROGRAMS



APS/AIP CONGRESSIONAL SCIENCE FELLOWSHIP

The American Physical Society and the American Institute of Physics are accepting applications for their 2003-2004 Congressional Science Fellowship programs. Fellows serve one year on the staff of a Member of Congress or congressional committee, learning the legislative process while lending scientific expertise to public policy issues. **Application deadline is January 15, 2003.** For more information, visit: http://www.aip.org/pubinfo or http://www.aps.org/public_affairs/fellow/index.shtml

APS Council and Committee Position Nominations

VICE-PRESIDENT; GENERAL COUNCILLOR (2); NOMINATING COMMITTEE; Vice-Chairperson-Elect • Members; PANEL ON PUBLIC AFFAIRS; Vice-Chairperson-Elect • Members

Please send your nominations to: American Physical Society; One Physics Ellipse; College Park, MD 20740-3844; Attn: Ken Cole; (301) 209-3288; fax: (301) 209-0865; email: cole@aps.org. A nomination form is available at **http://www.aps.org/exec/nomform.html**.

DEADLINE: JANUARY 31, 2003

APS Mass Media Fellowship Program

Applications are now being accepted for the 2003 summer APS Mass Media Fellowships. In affiliation with the popular AAAS program, the APS is sponsoring two ten-week fellowships for physics students to work full-time over the summer as reporters, researchers, and production assistants in mass media organizations nationwide. Information on application requirements can be found at **http://www.aps.org/public_affairs/massmedia/index.shtml.**

DEADLINE: JANUARY 24, 2003

Physical Review Focus

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

Some mid-October Focus Stories:

Nobel Focus: Neutrino and X-ray Vision
• The 2002 Nobel Prize in Physics went to three experimentalists who opened the window on cosmic neutrinos and x rays.

Dirt Radar
Microwaves reveal the structure of soil and suggest a cheap way to assess its likely agricultural productivity.

Missing Nuclei: Gone for a Reason
Improved calculations show in detail why there are no nuclei composed of five or eight particles in nature.

Prize & Award Nominations

http://www.aps.org/praw/

Otto LaPorte Award
DEADLINE: 01/10/03
Endowed by the friends of Otto Laporte and the Division of Fluid Dynamics.
Purpose: To recognize outstanding research accomplishments pertaining to the physics of fluids.

Fluid Dynamics Prize
DEADLINE: 01/10/03
Supported by friends of the Division of Fluid Dynamics and the AIP journal Physics of Fluids.
Purpose: To recognize and encourage outstanding achievement in fluid dynamics research.

Nicholas Metropolis Award for Outstanding Doctoral Thesis Work in Computational Physics
DEADLINE: 01/31/03
Establishment and Support: The award is supported by the Journal of Computational Physics, a publication of Academic Press.
Purpose: To recognize doctoral thesis research of outstanding quality and achievement in computational physics.

APKER AWARD, *from page 1*

University of California at San Diego conducted a series of experiments to measure the magnetoresistance and interfacial roughness for a set of magnetic multilayers, and since the length scale of the roughness was much larger that the Fermi wavelength, it was surprising to see a substantial increase in the resistance with both the current parallel and perpendicular to the layers.

Similar experiments by a separate group at Michigan State University didn't see any change in the resistance with increased interfacial roughness.

Alicea's thesis centered on finding a theoretical explanation for these unusual experimental results by carrying out the numerical solution of the Boltzmann transport equation.

He first found that the long length scale interfacial roughness decreased resistance when the current was flowing perpendicular to the layers—the opposite of the UCSD experimental results. He then tried the short mean free path limit, and found that the resistance increased with interfacial roughness when the current flows either perpendicular or parallel to the layers, just as the UCSD researchers observed.

In his manuscript, Alicea carefully addressed the question of which parameter regime one needs in order to see a resistance increase, decrease or no change at all, and these well-defined calculations will help guide future work.

Alicea presented his work at the 2002 March Meeting and has submitted the final manuscript for publication in *Physical Review B*. He received his B.S. in physics in December 2001 and is currently pursuing graduate studies in condensed matter theory at the University of California, Santa Barbara, with an NSF Graduate Research Fellowship.

Doret spent nearly two and a half years working in the atomic physics laboratory at Williams College, culminating in his senior honors project on the measurement of the Stark shift of an electric dipole transition in thallium. This work helps provide the atomic structure information required to relate the observed parity violations in atoms to the underlying parity-violating weak interaction.

He constructed, tested, redesigned and optimized important pieces of the optical system, the atomic beam system, the high-voltage system, and the data acquisition system. His significant improvements to the experimental apparatus enabled him to collect and analyze an enormous amount of high-precision Stark shift data.

Much of the experimental challenge for Doret was to identify and eliminate systematic errors. He performed extensive computer simulations, and completed many paper-and-pencil estimates of potential effects; proposed various experimental "checks" and some redesign of the data collection method and, based on this, has completed a thorough experimental exploration of potential errors.

His result was a measurement of the Stark shift with 0.4% accuracy, and experimental precision now far exceeds the precision of calculated thallium wave functions, presenting a challenge for future theoretical improvement.

Doret presented his results at the May 2002 meeting of the APS Division of Atomic, Molecular and Optical Physics in Williamsburg, VA, and has submitted the final manuscript to *Physical Review A* for publication.

He received B.S. degrees in physics and mathematics in May 2002 and is currently pursuing graduate studies in physics at Harvard University.

WISEMAN, *from page 5*

an associate administrator of science to help coordinate the research and technology aspects of homeland security. She also met regularly with high-level officials at various agencies, including NASA and the NSF, to discuss a broad range of policy issues.

The APS extended Wiseman's fellowship to the end of the year, when the 107th Congressional session is over, and next year she will return to JHU to continue her research on numerous projects in astrophysics. But her fellowship experience was so positive that she envisions being involved in some way with science policy and public outreach for the rest of her career. "This is the best job I've ever had," says Wiseman "I've enjoyed my work on the Hill and feel like it's a good fit. I was able to learn about and also influence many issues in science policy. That's one of the reasons I wanted to be a Congressional fellow: to gain more breadth of knowledge about science policy than one can get from a strictly research-oriented career."

The APS Congressional Fellowship program is intended to provide a public service by making individuals with scientific knowledge and skills available to members of Congress, few of whom have a technical background. In turn, the program enables scientists to broaden their experience through direct involvement with the legislative and political processes, which ideally will enhance not only their own careers, but the physics community's ability to communicate more effectively (see announcement on this page).

THE BACK PAGE

Tell the Truth About Particle Physics

By John Marburger

"We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.
Through the unknown, remembered gate
When the last of earth left to discover
Is that which was the beginning;
At the source of the longest river
The voice of the hidden waterfall
And the children in the apple-tree
Not known, because not looked for

But heard, half-heard, in the stillness
Between two waves of the sea.
Quick now, here, now, always—
A condition of complete simplicity
(Costing not less than everything)
And all shall be well and
All manner of thing shall be well
When the tongues of flame are in-folded
Into the crowned knot of fire
And the fire and the rose are one."

These closing lines of the fourth of T.S. Eliot's "Four Quartets" illustrate poetry's awesome evocative power. The language of poetry strikes resonances because its abstract manner of expression casts a broad net. The concrete words and subject matter are carefully chosen to awaken our perception of broad themes that reach far beyond the narrative of the poem.

I first heard these lines years ago in a talk by Thomas Cottrell, a medical dean at Stony Brook. They moved me so much that when it was my turn to speak, I put aside my notes and talked about the extraordinary convergence of particle physics and astronomy that was then emerging. The idea that somehow the end of the great reductionist adventure would be "to arrive where we started/ And know the place for the first time" seemed to capture a vision of the future course of fundamental science.

How convenient it has been for particle physics that Fred Hoyle's idea of cosmology turned out to be wrong. Hoyle's "continuous generation model" would offer little opportunity to probe the extremes of density and temperature that are typical at the origin of the rival "Big Bang model." The mechanism of the Big Bang—a phrase coined by Hoyle to ridicule the notion — turns the entire universe into a microscope. Distances out into space become times back into the past where scales shrink, and densities and temperatures soar. Our telescopes become detectors in the greatest high energy physics laboratory in nature, to observe the traces of the most awesome high energy event of all time.

We are very lucky to have this alternative means of studying microscopic phenomena, because the capacity of our technology to reach the necessary energies is lagging behind the phenomena we need to study. We know from galactic motions that there is more matter in the universe than we can see. And it seems likely that none of the stable objects in the current particle inventory of the Standard Model can account for it. But the exploration of the Standard Model itself, with its surprisingly wide spectrum of masses, has stretched our technology almost to the limit. We are at the ragged edge of society's ability to produce accelerators of the necessary size. We think we have the lightest Higgs excitation boxed in, and Fermilab's Tevatron may have a crack at glimpsing it. Surely CERN's Large Hadron Collider will excite a Higgs "something or other."

But the WIMPs, the Weakly Interacting Massive Particles that astronomers tell us must form clouds around all galaxies, may well have masses far beyond the scope of any accelerator yet conceived. It is important to understand these particles, because dark matter is important to the evolution of the cosmos. If we are going to use the cosmos as our laboratory, we need to know enough about the WIMPs to unravel their role in the cataclysmic early instants of the Big Bang. That means they have to be related to the Standard Model, and to the field theories whose details produce the properties of the vacuum.

Who ever would have guessed 40 years ago that understanding the vacuum—basically empty space in our frozen epoch of cosmic evolution—would be the most challenging problem in physics today? The discovery in 1998 that the expansion of the universe is accelerating is both embarrassing and exciting. There is nothing in our current theories that even comes close to producing the right order of magnitude for the term in Einstein's equation, the cosmological constant, required for this effect. What the theory gives is a joke, more than a hundred orders of magnitude off the mark.

The vacuum plays an essential role in the inflation theories, which lead to phenomena that must be understood to relate observable features of the universe to the structure and symmetries of microscopic models — models that may include strings, and that we hope will unify gravity with the gauge forces of the Standard Model. We are going to need all the help we can get to tie these future theories down to empirical reality.

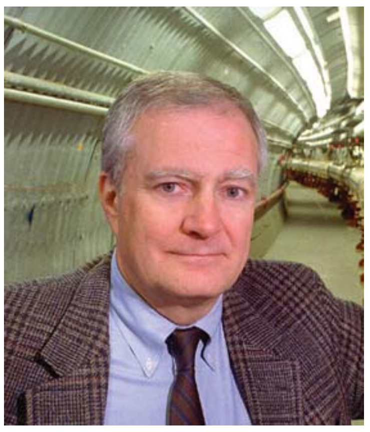
The argument for building an accelerator beyond the LHC must be strongly linked to these ideas. At some point we will simply have to stop building accelerators, and we must start thinking about what fundamental physics will be like when it happens. Theory, of course, will continue to run on. But experimental physics at the frontier will no longer be able to produce direct excitations of increasingly massive parts of nature's spectrum. There are two alternatives. The first is to use the existing accelerators to measure parameters of the standard model with ever-increasing accuracy so as to capture the indirect effects of higher energy features of the theory. The second is to turn to the laboratory of the cosmos, as physics did in the cosmic ray era before accelerators became available.

However, and whenever, this transition occurs, it is clear to me that the fates of deep space astronomy and particle physics are strongly entwined. In the long run, the future of particle physics lies in space-based experiments, and its productivity will depend on having a model of nature that is complete enough to exploit cosmic phenomena as a guide to theory. Now is the time to begin preparing for the long run.

Are we ready for this? When the last accelerator is built, will there still be a gap in our knowledge that will prevent us from working productively in the laboratory of the cosmos? There is no question that our ability to interpret what we see in the sky depends on what we have learned about fundamental matter in our earthly laboratories. How strong is this dependence? How much more do we need from earth-bound accelerators before we can do without them? And how can we best prepare for the end of the accelerator era in fundamental physics?

"For the first time in a quarter-century experiment is driving theory at the frontier, and not the other way around."

Society likes science. It is willing to tax itself to provide funds for basic, discovery-oriented research. It reads popular science books, watches educational television shows on science, and encourages its young people to study such impractical science topics as dinosaurs and black holes. In Congress, science enjoys bipartisan support. All postwar administrations have supported basic research, including the administration of President George W. Bush. But there is a limit. We saw this in the saga of the Super-



John Marburger

"At some point we will simply have to stop building accelerators."

conducting Super Collider. That project did not fail because of lack of love for particle physics, or even for lack of understanding of the importance of the Higgs mechanism. It failed, in my opinion, because the scale of the project exceeded a critical size—a size well within the ability of society to pay, but placed within a domain of society's parameter space that is unstable against chaotic behavior.

If the SSC was beyond a threshold of stability, and the LHC is beneath it, the Next Linear Collider is in a gray area. I have expressed elsewhere my conviction, in agreement with the High Energy Physics Advisory Panel, that the NLC is a logical choice for a next big accelerator after LHC. I think a lepton collider is the right kind of machine to do precision experiments of the sort that are going to be necessary to probe mass regimes that are out of reach. Perhaps we will find a way to keep building ever larger accelerators throughout the 21st century. But already with the NLC we are going to have to change the way such devices are financed. No single nation is likely to pick up as much of the cost of the NLC as host countries have in the past. To be successful, the project will need a new model of international support.

What can the science community do to increase the inclination of society to support these big machines? I think the best approach is to tell the whole truth. But it must be told carefully, in language that society can understand.

The truth is that particle physics is as exciting as it ever was. It is not dead. The fact that we are having trouble seeing beyond the Standard Model is not bad news. It means that the next discoveries will have a disproportionate impact on our understanding of Nature. For the first time in a quarter-century experiment is driving theory at the frontier, and not the other way around.

The truth is that Nature functions in such a way as to bring together the science of the very large with the science of the very small, and that opportunities have emerged for discovery about the fundamental nature of the universe that we never expected. Technology places these discoveries within our reach, but we need to focus efforts across widely separated disciplines to realize the new opportunities.

The truth is that exploration of the new frontier will attract the best young minds who will produce new technology to overcome the barriers which define the limits of our perception. The excitement of discovery, and the human will to see farther, are powerful sources of vitality in our society.

What we should not do is give the impression that the accelerators and other large scale apparatus are ends in themselves. Only the search for the ultimate shape of Nature can justify such large expenditures, and we must subordinate all other considerations to that grand end. Nor should we overemphasize the practical impact of new technologies that will emerge from the search. The proposition that high energy physics was responsible for magnetic resonance imaging devices, for example, is naive. Above all we should never assume that the lay public will not be able to appreciate what we are about. We need to support the science journalists who care, and those among us who have the knack of translating the fragmented and highly technical knowledge that is accumulating so rapidly into a coherent story as appealing to the lay public as it is to us.

I began with poetry, which can speak with such compelling effect that we imagine it to be the source of truth about ourselves and about the universe. This is an illusion. The truths that poetry evokes are within ourselves—within the experiences that lie in our memories and are drawn out by their resonances with the propositions of poetry's rhythmic lines. In the final analysis the exploration of the universe is necessary to humanity because it provides the basis for its grandest art. That sublime art, the comprehension in human terms, and the interpretation in human metaphors, of a decidedly unhuman universe, is the ultimate justification for powerful accelerators such as the LHC and NLC.

John Marburger is the director of the Office of Science and Technology Policy. This article is adapted from remarks made at the 40th anniversary celebration of the Stanford Linear Accelerator Center on October 2, 2002.