APS NEWS

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APS Members Choose Cohen as New Vice President in 2002 Election

In the 2002 general election, APS members have chosen Marvin Cohen, a professor at the University of California, Berkeley, and senior scientist at the Lawrence Berkeley National Laboratory, as the next APS vice president in the 2002 general election. He will assume office on January 1, 2003, becoming president elect in 2004 and APS president in 2005. The APS president for 2003 will be Myriam Sarachik (City College of New York).

In other election results, John Peoples of Fermilab was chosen as chair-elect of the APS Nominating Committee. Janet Conrad of Columbia University and Laura Smoliar of Lightwave Electronics were elected as general councillors.

Cohen professed himself "delighted" to be elected as APS vice president. He was born in Montreal and moved to San Francisco when he was 12 years old. He was an undergraduate at Berkeley and completed his PhD at the University of Chicago in 1964. After a one year postdoctoral position with the Theory Group at Bell Laboratories, he joined the Berkeley physics faculty. He became university professor in 1995. He has also been a senior scientist at the Lawrence Berkeley National Laboratory since 1995.

Cohen's current and past research work covers a broad spectrum of subjects in theoretical condensed matter physics. He is best known for his work with pseudopotentials with applications to electronic, optical, and structural properties of materials, superconductivity, semiconductor physics, and nanoscience. Cohen is a past recipient of the APS Oliver E. Buckley Prize and the APS Julius Edgar Lilienfeld Prize. In 2002 Cohen received the National Medal of Science.

He has served as a member and then chair of the Executive Committee of the APS Division of Condensed Matter Physics, as the US representative on the IUPAP Semiconductor Commission, and as a member of the

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Newly Elected APS Officials

VICE PRESIDENT
Marvin Cohen

GENERAL COUNCILLOR
Janet Conrad

CHAIR-ELECT OF THE NOMINATING COMMITTEE
John Peoples

GENERAL COUNCILLOR
Laura Smoliar

APS Counter Terrorism Task Force Meets on September 11

While the nation soberly observed a day of remembrance for last year's September 11 terrorist attacks, the APS Counter-Terrorism Task Force marked the occasion with a meeting at APS headquarters in College Park. Chaired by Bob Guenther of Duke University, the task force was given a very general charge, which includes surveying current activities of the physics community in the area of counter-terrorism, helping identify physics problems, and encouraging physicists to find solutions. Task force members held their first meeting May 3, 2002. A final report is expected to be presented to the APS Council later this month.

"The objective is to identify areas where the physics community can step forward to assist the government in its response to the attack of September 11," said Guenther. "We would like to not only identify technological response to current threats but also how we might reduce future exposure through the development of new technologies."

The bulk of the September 11 meeting was devoted to a series of technology review presentations, detailing the various areas where physics and physicists might contribute to national

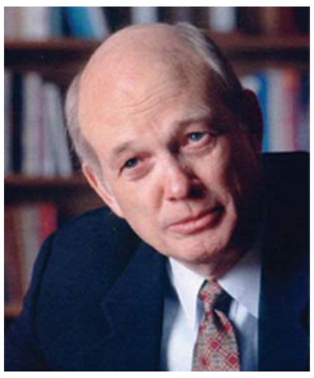
See TERRORISM *on page 3*

Viewpoint...

Scientific Fraud-Lessons Learned

By W. F. Brinkman, APS President

Editor's note: *In late September, the committee headed by Malcolm Beasley of Stanford, charged with investigating allegations of research misconduct at Bell Labs, issued its report. They found clear evidence of fraud by Jan Hendrik Schön, but no evidence of fraud by any of his collaborators. They left open the question of whether some of the co-authors had acted in accordance with their professional responsibility.*



W. F. Brinkman

Now that the Beasley committee has issued its report, it is time to consider what we have learned from the experience. I believe that there are three issues that the physics community must examine.

First, since Schön published his research in collaboration with several co-authors, we must carefully consider the responsibility co-authors have to the total content of the paper. This may require formulating new guidelines for our research journals.

Second, we must determine whether the physics community is appropriately alert to the characteristics of research fraud and scientific misconduct in general. This may

See FRAUD *on page 4*

Apker Award Finalists

Photo Credit: Laleña Lancaster

Every year the APS chooses two recipients of the LeRoy Apker Award for undergraduate research, one from a PhD-granting institution and one from a college that does not grant PhD's. The recipients are chosen from six finalists, who this year assembled in Washington on September 4th to be interviewed by the Apker selection committee, chaired by former APS President James Langer. Shown, left to right, are: S. Charles Doret (Williams College), Simon Sponberg (Lewis & Clark College), Jesse Thaler (Brown University), Lisa Larrimore (Swarthmore College), Rizal Hariadi (Washington State University), and Jason Alicea (University of Florida). The two recipients will be announced in next month's APS News.

Topical Conference Explores How Physics Can Help Biology

We are poised at a unique moment in time when physics can make important contributions to biology, according to speakers at the topical conference on "Opportunities in Biology for Physicists," held in Boston, MA, September 28 and 29. Aimed primarily at graduate students and postdocs in physics who are considering applying the methods of physics to biological topics, the conference was a first for the APS, which typically organizes between 20 and 25 general and specialized meetings per year so that scientists can share the results of their own current research with colleagres.

However, in June 2001, the APS Executive Board decided it would be advantageous to organize something different: a topical conference on an emerging field that would prepare early career physicists for future opportunities. "Rapid strides are occurring in biology where enormous technical and conceptual progress has been made in the last ten years," said Program Committee Chair Robert Austin (Princeton University) on the choice to focus on the biology/physics interface. "We believe that physics will make a substantial contribution to the revolution occurring in biology, particularly if biologists and physicists work together at this critical time."

See OPS IN BIOLOGY *on page 3*

Highlights

INSIDE THE BELTWAY:
A Washington Analysis

October Surprise? Not Really!

by Michael S. Lubell, APS Director of Public Affairs

October 1 arrived, but hardly anyone could have noticed that Fiscal Year 2003 had begun. For the first time in memory, Congress had failed to pass even one of the 13 appropriations bills needed to keep the government running. To tide the country over, lawmakers simply enacted a continuing resolution that allows departments and agencies to continue to spend at last year's levels but prohibits them from initiating any new programs.

For science, the news is not very good. Although the Bush Administration had only requested budget increases for National Institutes of Health research and Defense Department development, Congress was poised to add significant monetary resources to the coffers of the National Science Foundation, the Department of Energy's Office of Science and NASA's Space Science Program.

Hard work by the science community throughout the spring and summer months was indeed paying off. Had Congress finished its fiscal business before recessing for the November election, APS members, who had weighed in with more than 7,500 letters, faxes, e-mails and telephone calls, would have been richly rewarded. But whetted appetites will have to go unsated, at least for a while.

The story of the legislative collapse is worth recounting. Here's what happened.

For years, Pennsylvania Avenue has been a well-worn conduit for tension and invective between the

See **INSIDE BELTWAY** *on page 7*

Teaching Introductory Physics with Tales From the Subatomic Zoo

By Desirée Scorcia

While physicists and physics teachers across the country are searching for better ways to teach physics to high school students and college non-majors, Cindy Schwarz, a physics professor at Vassar College, has taken a novel approach to the problem. Schwarz teaches an introductory physics class at Vassar College called "A Tour of the Subatomic Zoo." The class is aimed at non-science majors, and requires no previous knowledge of physics.

That alone would not be unique. But as a final assignment in the course, Schwarz requires that her students write either a fictional story or poem about subatomic particles. Some years, they have also been given the options of writing about the failure of the SSC project, the search for and the discovery of the top quark, and the use of accelerators in medicine. But Schwarz says she is thrilled when students choose the more creative options.

Schwarz's unique approach appears to be working: her students are walking away from the class with a good understanding of particle physics and the policy behind it. And the proof is out there, at your local bookstore. This year, Schwarz compiled her favorites of these stories into a book called *Tales From the Subatomic Zoo*. "I had wanted to put them into a book to show to other people for quite a while," she said. "I think it's a really a nice way to show what you can do with liberal arts students who can take physics and use it in really interesting ways. I have over 300 stories and poems, and the students have continued to amaze me, delight me, really show what liberal arts students can do."

"I started the class because we don't have a science requirement at Vassar," said Schwarz, "and I was concerned that students could leave Vassar without taking any science at all. So I created this class, and gave it a snazzy name so the students would take it." Schwarz first taught the class in 1987 and has offered it for about ten of the past 15 years. In that time, she's taught approximately 400 students, from philosophy to French to art majors.

The key, Schwarz says, is to present physics in a way that is both interesting and relevant to their lives and education. "Why

See **SUBATOMIC ZOO** *on page 6*

This Month in Physics History

November 1872: Death of Mary Somerville

Distinguished women in science were few prior to the dawn of the 20th century. Among the most prominent was Mary Fairfax Somerville, a twice-married Scotswoman whose international reputation as a scientist was gained in the intervals of raising a family of six children. Her achievements are all the more remarkable given her lack of formal education and the context of the repressive society in which she lived, where it was unthinkable for young women to purchase books, especially on math or science. Her perseverance in pursuing scientific endeavors caused her to be publicly denounced in York Cathedral, but in the end her work earned her distinction among her colleagues.

Born on December 26, 1780, in Jedburgh, Scotland, Somerville was the daughter of a vice admiral in the British Navy. Her formal education was scant and rather haphazard, with only one year of full-time schooling at a boarding school for girls, where she was miserable. But it was there she acquired a taste for reading. She studied her first arithmetic at age 13, and discovered algebra quite by accident when she happened upon some mysterious symbols in the puzzles of a women's fashion magazine and learned they were algebraic expressions. Intrigued, she persuaded her brother's tutor to purchase some elementary literature on the subject for her.

Marriage intervened in 1804, when, at 24, she married her second cousin, Samuel Grieg, a member of the Russian Navy with little interest in math and science and a low opinion of intellectual women in general. She quickly bore him two children, but he died three years into the marriage, leaving her with a comfortable inheritance. Now financially independent, she was free to study as she pleased. She quickly mastered J. Ferguson's *Astronomy* and also studied Newton's *Principia*, gradually building up a small library of works to provide her with a sound background in mathematics. She remarried in 1812 to William Somerville, a surgeon in the British Navy who was very supportive of her intellectual endeavors. They had four children together.

Mary Somerville

Her scientific career began in earnest in the summer of 1825, when she carried out a series of experiments on magnetism, presenting a paper on her findings the following year to the Royal Society. Apart from the astronomical observations of Caroline Herschel, it was the first paper by a woman to be read to the Society and published in its *Philosophical Transactions*. Although the theory presented in her paper was eventually refuted by other scientists, it distinguished her as a skilled scientific writer and was favorably received by her colleagues.

In 1827 she was asked to write a popularized rendition of LaPlace's *Mecanique* and Newton's *Principia*, aimed at reaching a larger audience by communicating the concepts clearly through simple illustrations and experiments. *The Mechanism of the Heavens* (1831) was a tremendous success and became the most famous of her writings. Her second book, *The Connection of the Physical Sciences*, was published in 1834, and dealt with physical astronomy, mechanics, magnetism, electricity, heat, sound and optics. It earned her election to the Royal Astronomical Society, along with Caroline Herschel, the first women to receive such an honor.

In 1848, at age 68, she published yet another book, *Physical Geography*, which proved to be her most successful yet and was widely used in schools and universities for the next 50 years. She and her husband had moved to Italy in 1838 because of his deteriorating health, and he died in 1860. Somerville and her surviving daughters stayed in Italy, where she continued her scientific work, publishing *Molecular and Microscopic Science* in 1869, her least successful work. But she remained mentally alert and keenly interested in mathematics despite her advancing age, and was revising a paper on quanternians the day before she died peacefully at 92 in 1872. London obituaries hailed her as "the Queen of Science."

Throughout her life, Somerville felt keenly that she was not an original scientist, and, a product of her age, thought that perhaps women were not gifted with that type of creativity. But she clearly demonstrated great mathematical and scientific intelligence and had a talent for evaluating conflicting ideas, and for organizing and synthesizing knowledge in clear and accessible prose. Her first three books contributed enormously to scientific education through most of the 19th century and she acted as mentor to many young scientists, both male and female.

Somerville's significance continued after her death. A ship built in Liverpool, England bore her name and carried her image as its figurehead. An Arctic island, and a girl's college in Brisbane, Australia are also named after her, and Oxford University founded its first college for women in her honor. Somerville College played a leading role in the many battles for equality that were waged in the early 20th century, and, like Somerville, its alumnae have pioneered career opportunities in fields where women were historically excluded.

Further Reading:

Neeley, Kathryn A. *Mary Somerville: Science, Illumination and the Female Mind*. Cambridge University Press, October 2001.

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NUMBER TEN

Unity of All Elementary-Particle Forces

H. Georgi and S. L. Glashow, Phys. Rev. Lett. 32, 438 (1974), 1946 citations

With this article, APS News *begins a special feature by James Riordon on the ten most-cited papers published in* Physical Review Letters *since its inception in 1958. The citation data have been provided, not quite free of charge, by the Institute for Scientific Information (ISI), publishers of the* Science Citation Index.

In counting down in the coming months to the top-cited paper of all time, our intention is not just a mad desire to mimic David Letterman or the DJ on the local radio station. We want to provide some insight into what makes these papers significant and how they came to be written. Our treatment will be more descriptive than scholarly: space will not permit us to include numerous references nor to branch out to discuss related work in the text.

Even though PRL is the most highly-regarded physics journal, and citations are certainly one possible measure of a paper's significance, we do not claim that the ten papers to be featured here are necessarily more significant than many other papers that have appeared in the literature over the same span of time. But these papers range over many different fields of physics, and their impact has been great. We hope our readers will enjoy finding out more about them.

The tenth paper in our list of the top ten, most-cited *Physical Review Letters* is the seminal work that instigated serious pursuit of Grand Unified Theories (GUTs). "It was a fun paper," laughs Howard Georgi when asked about the *Unity of All Elementary-Particle Forces.*, "It was very early, well before we really understood all the pieces. It was just fun finding this way to put them all together."

Progress in particle physics had been relatively slow through much of the 1960's, but Georgi knew he was in the right place at the right time when he accepted a postdoctoral fellowship at Harvard in 1971. Gerard 't Hooft had just published his proof of the renormalizability of theories such as Steven Weinberg's gauge model unifying the weak and electromagnetic forces. A review of 't Hooft's arguments by Ben Lee in late 1971 inspired a host of Harvard theorists to set to work on various aspects of gauge theory. Georgi soon joined Sheldon Glashow in pondering renormalizable gauge models.

Together, Georgi and Glashow attempted to unify SU(2) and U(1), with little success, until the end of 1973. A breakthrough finally came in January 1974. Georgi explains that their key revelation essentially resulted from an act of desperation—the attempt to incorporate strong forces into their gauge models. "Shelly and I realized that the strong interactions didn't really have to be strong, and that one could imagine unifying them with the weak and electromagnetic interactions." In a single day, that revelation led Georgi to the SU(5) group. "It happened in two stages," says Georgi, "I actually found the SO(10) model before the SU(5) model, by about an hour, because it was easier to see what to look at. It was only after I found out that I had managed to take it apart into SU(5) that I realized how obvious it was."

"I had gone home and, after dinner, worked it all out in a few hours," recalls Georgi. The SU(5) model he discovered was astonishingly simple, and economically fit leptons and quarks into a single group. But Georgi's newfound theory apparently had one unavoidable drawback— it predicted that the proton should decay into a positron and a neutral pion. "I finally went to bed when I found out that the proton decayed, "says Georgi, "which to me was rather depressing." After all, as far as he knew, the proton was stable. "When I came back and described this to Shelly, that's what got him excited. He was right, of course, because that was the interesting experimental consequence of all this. At that point, we worked out in more detail what the bounds on the proton decay were at the time and wrote the paper up."

In the decades since Georgi and Glashow published their revolutionary paper, experimentally determined lower limits on the proton lifetime have eliminated a host of GUT models, including the SU(5) model. But their 1974 work is frequently cited as the prototypical grand unification model, particularly in the introductory sections of the latest GUT papers.

Georgi is still at Harvard, and now holds the Mallinckrodt chair in the Physics Department. Sheldon Glashow shared the 1979 Nobel Prize with Abdus Salam and Steven Weinberg for efforts leading to electroweak unification, and is currently Metcalf Professor of Math & Science at Boston University.

Although Georgi rarely works on grand unification theory these days, he finds the tools he picked up during the golden GUT days of the seventies handy in his current work on gauge theories, and has written a graduate Lie algebra text to introduce the powerful techniques to a new generation of theorists.

Georgi believes the jury is still out when it comes to grand unification schemes. "It depends on the day," he replies when asked if he thinks we will ever find the correct grand unified theory. "Who knows? It would be nice to see proton decay, if it's really there. The trouble is that we don't have very many experimental handles on this," says Georgi. "At the moment it's a little bit ethereal. But it's absolutely gorgeous the way these things fit together. That was, for me, always the extraordinary thing."

OPS IN BIOLOGY, *from page 1*

The invited talks gave general overviews of key issues in five basic topics: genomics and evolution, biological networks, biomolecular dynamics, high resolution imaging of living cells, and physical devices for biological investigations. In her welcoming remarks, APS Executive Officer Judy Franz expressed the hope that the proceedings would encourage more cross-communication between the two disciplines. "We didn't just want to preach to the choir," agreed Austin. "We can no longer afford the elitism that has so often typified physics in the past." Participants included 90 graduate students, 60 postdocs, and 70 more senior physicists.

Nearly every speaker on the program emphasized the critical need for collaboration between physicists and biologists, while recognizing the inherent difficulties, due to the different cultures and language employed by the two disciplines. Harvard University's Andrew Murray is among those who believe that biology is currently changing from a descriptive to a quantitative and conceptually profound field, implying deep principles that govern the field, and hence there is a critical need for physicists to help define them.

" Currently, biologists can make qualitative predictions, but they would like to be able to make quantitatively accurate predictions, he said."

Murray outlined three key roles physicists can play in the emerging revolution in biology, which were echoed repeatedly by other speakers. First, physicists can offer a fresh perspective and their aggressive reductionism can aid in the drive to develop a philosophy of underlying essential principles. They can also help improve accurate data collection so that predictions can be tested. "It's so difficult for biologists to generate theory that's experimentally testable," said Murray. And finally, physicists can continue developing useful techniques, not just through instrumentation, but through applied mathematical techniques to help convert biology's verbal logical models into formulas that explain the real world.

There were also two panel discussions. The first focused on how to make the transition to a career at the physics/biology interface. Five young physicists who have done so talked about how and why they chose to work in biological topics, and were able to offer useful advice to those in attendance who might be interested in doing the same thing. Ultimately, they agreed, it is vital to "know thyself" and follow the research that interests and excites you, rather than research that is deemed "important."

Photo credits: Alan Chodos

Above: Shirley Tilghman of Princeton University introduces her talk on Epigenetics. Left: At "Lunch with the experts", David Agard of the University of California, San Francisco (arrow), shares his insights with graduate student attendees.

The second discussion focused on funding opportunities for those interested in working in this area, and featured short presentations by representatives from several key funding agencies and foundations. The representatives were able to offer useful pointers on the grant application process.

The two-day conference concluded with a brief presentation by the "grandfather of biological physics," Hans Frauenfelder (Los Alamos National Laboratory), who reiterated many of the themes sounded by other speakers. "Collaboration is crucial, not just between physics and biology, but also with chemistry, computer science and mathematics," he said. "But these different fields have vastly different approaches, and we must learn their language to avoid misconceptions."

TERRORISM, *from page 1*

efforts to counter-terrorism.

The meeting kicked off with a discussion of biomedical issues, focusing on such bioterrorist threats as anthrax. Biodetection of these agents must be extremely rapid, particularly since early treatment of exposure to anthrax is often successful, whereas later treatment usually fails to save the patient. Current biodetection methods include molecular biology, immunology, mass spectrometry and spectroscopy. Other speakers focused on detection of common chemical weapons, as well as the issue of nuclear and radiological weapons.

In airport security, non-destructive detection methods are preferred, including the use of various x-ray technologies. Others under development include elastic neutron scattering, thermal neutron activation, nuclear resonance absorption, and vapor/particle detection devices. Future applications of such technologies include detection and characterization of underground structures, clandestine sensing of terrorist activities, and support of anti-terrorist forces with portable sensors and surveillance-enhancing equipment. Detection of explosives concealed in baggage or packages, and the problem of undetonated land mines still littering many war-torn countries (see *APS NEWS*, July 2002, p. 8), are also areas of major concern.

One of the more promising areas for physics to contribute to anti-terror efforts is the burgeoning field of nanotechnology. Specifically useful research areas include the development of miniaturized intelligent sensor systems for detection of chemical and biological agents; nanofibers for protective clothing; nanoporous materials for selective separation of molecules; and new mechanisms to disrupt biological agent viability. The latter has yielded particularly exciting breakthroughs, such as employing certain classes of proteins to change the properties of toxic biological molecules.

The other members of the task force are Mark Coffey (TRW), Harold Craighead (Cornell), Leonard C. Feldman (Vanderbilt University), William R. Frazer (University of California, Berkeley), Gerard P. Gilfoyle (University of Richmond), Martin V. Goldman (University of Colorado), Beverly K. Hartline (Argonne National Laboratory), and Paul Wolf (Air Force Institute of Technology).

LETTERS

Imposing ideology is an offense

I'd like to comment on the recent article by Lawrence Krauss in the August/September 2002 issue of *APS NEWS*. I agree with Krauss that science imposes constraints on what is possible. I agree that greater emphasis should be placed on mechanisms and plausibility than on stories woven from circumstantial evidence. However, that is precisely the point of the intelligent design advocates whom he is disparaging: that intelligent design is a logical inference based on current knowledge of the limitations of known mechanisms.

I also agree that science is not "fair" in the sense that only those theories that have satisfied the test of experiment can stand. But this principle also readily leads to design inference. It is the lack of experimental evidence that naturalistic mechanisms can generate specified complexity or construct irreducibly complex systems that supports this inference.

Intelligent design and naturalism are both possible inferences that one might make from the data and knowledge of science. To simply eliminate one a priori is to impose an ideology. This is the offense that must be avoided. The solution I propose is to teach the methods and data of science without imposing a prior commitment to any ideology, including naturalism. Encourage the relentless pursuit of natural causes, but frankly evaluate and discuss current knowledge of the capabilities and limitations of known mechanisms. Allow for the possibility that naturalism is not a complete description, and this will lead to a more honest evaluation of the evidence and protect the integrity of science.

Mike Kent
Albuquerque, New Mexico

Do Your Homework Before Entering UFO Fray

The August/September 2002 issue of *APS NEWS* contains an interesting article by Lawrence Krauss that deals, in part, with his experience in participating in a debate on the problem posed by so-called UFO sightings. Since I have studied this problem for 30 years, I can perhaps offer supplementary advice coming from a different perspective.

Here are my recommendations to physicists invited to take part in such a discussion:

1. Either stay away completely or do your homework first. This is a very complex subject, and "doing your homework" will not be quick, easy or painless.

2. Do not imagine that training in physics provides you with any relevant credentials that enable you to pontificate on the problem. [Expertise in forensic science would be another matter.]

3. Read the Condon report from cover to cover— preferably from back to front so that you can better judge the extent to which Condon's conclusions and recommendations follow from the work of his staff. (E.U. Condon, D.S. Gillmor, *Scientific Study of UFOs*, Bantam Books, 1969)

4. Learn something about the history of the subject. An excellent summary of the early days of the controversy can be found in *The UFO Controversy in America* by D.M. Jacobs (Indiana University Press, 1975).

5. You might also wish to learn what a nongovernmental scientific review panel had to say about the subject by perusing my own book, *The UFO Enigma: A New Review of the Physical Evidence* (Warner Books, 1999).

6. Finally, bear in mind that although most scientists treat this subject as a joke, the public does not, and we would do well to treat their concerns with respect.

Peter A. Sturrock
Stanford, California

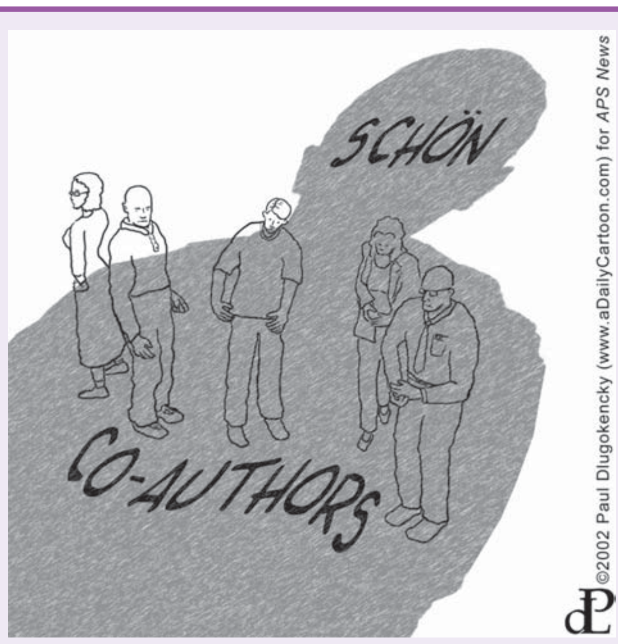
Don't Abandon Industry

Finding interesting jobs is always hard, and finding any job in a recession is hard, so Michael Lubell's latest "Inside the Beltway" comments on the post-high-tech bubble [*APS NEWS*, August/September 2002] are valid. True, for the next few years most growth will be financed by government deficits.

But before physicists all abandon industry and turn to the government for jobs, they might want to ask themselves some simple questions. If all manufacturing moves offshore, where will the government find the money over the long term to create all those jobs for physicists? And where will universities obtain their funding?

James C. Phillips
Summit, New Jersey

EDITORIAL CARTOON



Origin of Life a Complex Question

A very common debating tactic is guilt by association, or "the grab bag of enemies." By implication, one cannot be a proper intellectual without adopting the entire list of enemies. Lawrence Krauss does this very well in his "grab bag of nuts" essay, in which he includes believers in UFO's and magnetic healing along with those who believe in intelligent design. What better way to discredit the legitimate questions that many people have about the origin of life?

Most of us have sat through biophysics seminars in which the speaker talks in awe-inspiring tones of the "wonderful design," and "fine tuning" of the "molecular machines." But apart from a perfunctory reference to natural selection, we rarely discuss how this all came to be. We all know why — we haven't a clue. There is no quantitative theory, nor even a widely accepted qualitative model, for how life began from nonliving material. Experiments on these mechanisms have shown us barriers to their spontaneous appearance, not pathways. The more we learn about the mechanisms of life, the greater is the problem of understanding the origin of life. Is it heresy to admit that in public?

Modern science makes the assumption that life began only by simple, natural processes. This is a reasonable assumption, given the success of the assumption of simplicity in other areas. We cannot go beyond the facts, however — in the case of the origin of life, it is just an assumption. Despite decades of well funded effort, this assumption has not found direct experimental support We have no physical understanding, nor even a good physical model, for how all the molecular machines came about. There has been no successful production of life from non-life even with significant intervention of intelligent experimentalists. If some people make the assumption of purposive design, whether through predestined evolution or direct intervention, are they being wildly irrational?

Krauss says he would ask a creationist whether he believes in UFO's. Those who believe in intelligent design would say, "I don't believe in a physical mechanism for origin of life for the same reason I don't believe in UFO's— I haven't ever seen one." When a quantitative naturalistic mechanism for the origin of life comes along, it will, like a picture of a UFO, be compelling. Until then, it is simply a working hypothesis.

Physicists stand to lose face if they continue to say that our understanding of the biophysics of the origin of life is just as well established as other physical theories such as gravity and relativity. In view of the lack of progress of biophysics on the origin of life, we may just end up casting doubt on our credibility when we talk about electric power lines or nuclear energy.

Physics has historically always made the assumption of simplicity in tackling new problems. Life is manifestly complex, however. We all know the joke about "Consider a spherical cow." If we charge into the realm of biology saying, "Of course, we physicists know it is all very simple," are we clearing things up, or are we just forcing an old paradigm onto a new field? Could it be that some complex things have complex causes, causes as complicated as persons themselves?

The issue is not the age of the earth. The issue is that people well know that many things in biology are mystifying, and scientists who talk as though they know there is nothing deep about it just sound pompous and brash.

Richard Jones
University of Connecticut
David Keller
University of New Mexico
Phil Skell
Pennsylvania State University
Fred Skiff
University of Iowa
David Snoke
University of Pittsburgh

FRAUD, *from page 1*

require an effort on the part of the APS to help educate the community.

Finally, we must determine whether the scientific process worked effectively in revealing the fraud in Schön's research. It is possible that the fraud was only exposed because of the influence of outside forces.

I'll consider each of these in turn.

In the case of co-authors' responsibility, the Beasley committee said that it could not find clear ethics statements on this issue. They cited a Policy statement by the Deutsche Forschungsgemeinschaft, a quasi-governmental German research agency, that flatly states:

"Authors of scientific publications are always jointly responsible for their content. A so-called 'honorary authorship' is not admissible."

As the Beasley report points out, this is not a workable policy. In most fields of physics, some of the authors contribute specific things — such as crystals of the material of interest — and are therefore not involved in the detailed research. Under these circumstances, a co-author may not be responsible for the full content of the paper. In the ethics statement by the National Academy of Sciences "On being a Scientist" this issue is discussed. It says:

"As with citations, author listings establish responsibility as well as credit. When a paper is shown to contain error, whether caused by mistakes or fraud, authors might wish to disavow responsibility, saying that they were not involved in the part of the paper containing the errors or that they had very little to do with the paper in general. However, an author who is willing to take credit for a paper must also bear responsibility for its contents. Thus, unless responsibility is apportioned explicitly in a footnote or in the body of the paper, the authors whose names appear on a paper must be willing to share responsibility for all of it."

No journal that I know of has a policy where responsibility is apportioned. Indeed, I believe that "apportioned responsibility" is not a workable policy. Nevertheless, it is clear that the physics community must develop a guideline that succinctly defines the responsibilities of co-authors. At a minimum, this guideline should state that while, under certain circumstances, there may be co-authors who should not be held responsible, there is always a senior author who must take responsibility.

I should also point out that this current interest in the responsibility of co-authors is not simply a result of the Schön affair. It was also a very contentious issue in the recent evidence of misconduct in the research that led to the claim of the discovery of element 118. I believe this means that the broad physics community should work together on this issue.

The second issue that these cases of fraud raise is whether the physics community is appropriately alert to the characteristics of research fraud.

The current cases of fraud were clear-cut but there are many more subtle examples that scientists should be aware of. Being sure to give proper credit is one example. The responsibility of reviewers regarding the information they obtain in the review process and the co-authorship discussed above are others. I believe that the APS should encourage physics departments to foster discussion of these issues among their graduate students.

I am reminded of the time R. E. Peierls was asked why he recommended Klaus Fuchs for work at Los Alamos in the Manhattan project. Peierls responded that morals were never discussed in his community of physicists as everyone was assumed to have the same high standards. I believe that we need to do better than that.

The third issue is that some are proclaiming that the scientific process worked. That is, people familiar with the subject matter were extremely suspicious of the published results and did not believe them. It is true that most of the community was wary of the results as they seemed to have either pushed the limits of what is physically possible or had seeming inconsistencies in them. However, until people outside the subject area actually pointed out examples of apparent fraud most practitioners thought the authors might be wrong but did not think in terms of fraud. This rather innocent attitude is another reason that education of the community seems so necessary.

The APS's Panel on Public Affairs Subcommittee on Ethics is currently examining these issues and will put forth new suggestions as to how the Society and its members should address all these issues in the near future. It is clear that we need to develop new policies particularly with respect to the role of co-authors. We will keep the community informed as this process continues.

zero gravity
The Lighter Side of Science

The Craft of the Improbable Science Writer: The Art of Rejection

By Steve Nadis

***Editor's Note**: Apparently, the* Annals of Improbable Research *has a very high rejection rate—higher than most of the "serious" science journals such as* Nature *and* Science. *The following is an example of how far certain would-be authors go to try to get their works published in* AIR.

Improbable science writers are, by and large, a hardened lot. They have to be to keep doing what they do. In the course of their work, they're constantly sending out proposals to heartless editors and getting most of their entries sent back in the dreaded SASE (self-addressed stamped envelope). For me, about the only thing that's not being rejected these days are my phone bills. (Not to worry—just a temporary slump.)

Rejection letters assume various forms and are, in fact, an artform onto themselves. Here are some recent examples, just to give you a feel for the genre:

"Dear Mr./Mrs./Ms. _____," wrote the editor of a prestigious journal.

"Thanks for giving us the opportunity to read 'Sex and the Silicon Cell.' I'm sorry it does not work for our magazine, but please send more on the subject for my private use."

And: *"Thanks for sending us 'Wetlab Zombies.' I'm afraid it is too fringy, even for* Frontier News.

Or: *"Thanks for giving us a look at 'Astrophysical Platitudes Amidst the Latitudes,'* wrote the erstwhile editor of The Journal of Dubious Findings. *"While the research you cite is undoubtedly dubious, it is also unspeakable, as well as trivial."*

Note the infinite variety, elaborate construction, deft use of irony, and subtle shifts of tone characteristic of the rejection oeuvre. As written testaments, penned by some of the world's highest-ranking literary authorities, these letters are treasures to be mined for all they're worth. Rather than cranking out one mindless article proposal after the next, aspiring improbable science writers would do well to study their rejection letters carefully and learn from the true masters of the craft.

Occasionally, though rarely, the illustrious author of the rejection letter completely misses the point.

To wit: *"We liked 'The Thermodynamics of Volleyball,' but unfortunately we do not cover volleyball. However, if you'd like to do a piece on the thermodynamics of racquetball, walleyball, tennis, or squash, please get back to us."*

My reply was equally vacuous: *"Sorry, I don't do racquetball, tennis, walleyball, or squash. Improbable science writers, I'm told, are supposed to write about what they know. For me, that happens to be the thermodynamics of volleyball. Such is life."*

In that instance, I committed a serious breach of the improbable science writer code: **I lost my temper**.

Sure, sometimes the process is enough to test anyone's mettle. But the seasoned professional realizes that such immoderate outbursts will never advance his career, nor will they advance the cause of improbable science education to which he has devoted every waking second of his conscious life.

Rather than sitting back and waiting for rejection, the industrious writer takes the offensive.

"To whom it may concern," I once wrote.

"After grave deliberation, I have decided not to submit my neurological treatise, 'The Man with Two Eyes and One Nose.' In fact, I have decided not to write it. Even so, my story would probably not be right for your magazine, nor you for it. Regrets..."

Of course, emissaries of the improbable science editorial establishment are not always such a bad lot. Sometimes, they're so contrite and apologetic, I actually feel sorry for them. An editor from *Half Truths* sent me this heartbreaking missive:

"Dear Mr./Mrs./Ms. ____, I found your story on 'Isotopes at the Sushi Bar' intriguing, as well as disconcerting. It has been an extremely difficult decision, one that I've grappled with over many sleepless nights. But I finally realized that when there is so much debate and so much soul-searching, the answer, ultimately, has to be no. Sorry you had to be the victim of my learning process."

At times like these, I (as would any other responsible improbable science writer) often send back soothing notes to comfort the poor rejector and ease my own conscience.

"That's OK," I say. *"Don't feel bad. I realize you're literally swamped with manuscripts and can only accept a tiny fraction of the material you receive. I know you'd like to be able to publish more, if only space and budgets permitted. I know all this, yet I keep sending these things. Sorry. I'd stop if I could."*

Steve Nadis is a freelance science writer. The above article originally appeared in Annals of Improbable Research, *May 2002. Reprinted with permission.*

Electronic Voting a Hit with APS Members

The 2002 APS general election was the second year that the Society offered members the option of voting electronically, with 87.9% of those voting opting for the electronic method. Several members also took the opportunity to offer their comments on the electronic voting process. The feedback was overwhelmingly positive, with members praising the ease and convenience of electronic voting, and noting the particular benefit to overseas members and those on sabbatical leave.

A few people experienced technical difficulties in navigating the site, and some had trouble remembering their assigned ID codes, but most echoed the sentiments of one commentator who observed, *"This process is much faster and allows those of us who find ourselves in a hectic, fast-paced environment to respond to the election with minimal voting time."* (Or, as one vernacularly inclined member phrased it: *"Like, totally awesome, dude!")*

There were some suggestions for improvement. Several people decried the lack of descriptions on the site for each of the positions up for election, and one member suggested adding streaming audio files of all candidates discussing their respective mission statements and priorities for the Society.

Concern about on-line security was also a major issue, and several members objected to the use of "cookies" in the electronic voting process.

Ken Cole, the APS administrative staff member in charge of organizing the election process, reports that the cookies used in the process were temporary and used only to improve online security by ensuring that votes were being cast from the same computer on which the login was authorized. Once voting was completed and the user had left the secured Website, the cookies were deleted.

The Society hopes that the availability of electronic voting will lead to much wider participation by APS members in the election process, although to date the gains have been modest. There was a total of 10,638 ballots cast out of a possible 42,701 members eligible to vote, which translated into 24.9% ballots returned, up slightly from last year's 23%. But at least one member admitted, *"I may not have voted but for this convenience,"* while another concluded, *"Now there is no excuse for not voting."*

ELECTION, *from page 1*

National Academy of Sciences Government-University-Industry Research Roundtable. Cohen has also served on a variety of national and international boards and committees as an advisor and advocate for science education. He was vice chair of the NAS-GUIR Working Group on Science and Engineering Talent emphasizing the recruitment of women and minorities. He was a featured speaker for the Electron Birthday Project (televised to US high schools) and is currently active in lecturing to lay groups, K-12 students, and industrial groups.

Cohen's interest and experience in education and outreach is reflected in his candidate's statement, in which he identified the promotion of physics education as a primary objective for his tenure in the APS presidential line. "We've seen discouraging trends in the number of students choosing physics majors worldwide during the last few years," he said. "The APS must try to help in the recruitment into physics of qualified students, and take a prominent role in improving physics education, especially at the pre-college level."

He also emphasized the importance of the Society's role in advising policy makers regarding federal funding for science, and in providing the best science-based recommendations in such areas as security, commerce and human welfare. "I love physics and want to promote it," he said. And despite all the talk of biology taking precedence in the 21st century, he believes physics is "still the central science, with huge applications in biology, chemistry and engineering. I think its future is as exciting as its past."

Peoples is a senior scientist in the Fermilab Experimental Astrophysics Group and director of the Sloan Digital Sky Survey. He received his PhD in physics in 1966 from Columbia University. He was an assistant professor in physics at Columbia from 1966 to 1969 and at Cornell University from 1969 to 1972. He joined Fermilab in 1972 and during the next 16 years he was engaged in the construction and management of experimental facilities and accelerators for high-energy physics. He served as deputy director in 1988 and director from 1989 to 1999. He was appointed director emeritus in 1999, and chaired the APS Division of Particles and Fields in 1984 and the APS Division of Physics of Beams in 1999.

In his candidate's statement, Peoples cited the need for the Society's elected leadership to provide a clear vision for the APS and its role in diffusing the knowledge of physics both in the physics community and society at large. "Our leaders must be advocates for the physical sciences in these times when the nation's research portfolio is changing.... At the same time, they must reflect the diversity of present and future members and the citizens of our nations," he said. And as chair-elect of the APS Nominating Committee, "I will do my best to persuade the most able of our members to stand for election in these offices."

Conrad was born in 1963 in Wooster, Ohio. She received her PhD in physics from Harvard University in 1993. Since that time, she has been associated with Columbia University and is presently an associate professor. Conrad's research focuses on using neutrinos as tools to search for beyond-the-standard-model physics signatures. She was given the Marie Goeppert-Meyer Award in 2001 for her leadership in the search for neutral heavy leptons at the NuTeV deep inelastic neutrino scattering experiment at Fermilab. She was a cofounder and is co-spokesperson of the MiniBooNE neutrino oscillation experiment. Conrad has been active in the APS since she was a graduate student.

Conrad said she is looking forward to a "rewarding and interesting experience" as an APS general councillor. Her goals include further enfranchising the younger members of the physicists' community, increasing the society's efforts to communicate the excitement of physics research to the public, and maintaining balanced federal support for physics. "Physics is a wonderful and startling field, and I want to be a part of sharing the news," she said. "I think the APS Council plays an important role in influencing the national discussion on science policy and education, and I see my position as a way to do my part in increasing the visibility and vitality of the field."

Born in New York City, Smoliar earned her PhD from the University of California, Berkeley. She has worked in Silicon Valley since September, 1996. Initially she worked in the data storage industry at Seagate Technology. In 1998, she cofounded a start-up working on three-dimensional laser-based displays, where she built a development group in photonics materials for upconversion displays. She then worked on a MEMS technology called the Grating Light Valve (GLV) for laser projection display, before deciding to invest her efforts in driving laser development to meet the needs of the laser display community. She was recruited by Lightwave Electronics, a small privately-held photonics company in Silicon Valley, to lead a development program aimed at the display industry. At Lightwave, she manages a multidisciplinary group of engineers and physicists, working very closely with development partners in Asia and Europe. Smoliar has been very active in the APS Forum on Industrial and Applied Physics.

Given her industrial background, Smoliar understandably emphasized that aspect in her candidate's statement, calling for the APS to do even more to bridge the gap between the physics community and the world of technology companies, many of which may not fully realize the enormous value of having a physicist on staff. "I think my election is timely, since there is a real opportunity for the APS to aid industrial physicists and graduates first entering the job market who are facing a tough economic climate in the technology sector, she said. "My background will enable me to make special contributions in bridging the gap between industry and academia, and I feel very honored to have been elected."

PHYSICS AND TECHNOLOGY FOREFRONTS

Flat Panel Medical Imaging

By R. A. Street

X-ray imaging for medical diagnosis began soon after Roentgen discovered x-rays in 1895, but it has taken 100 years to replace x-ray film with a digital imaging technology. Digital imaging has the benefits of immediacy in acquiring the image, electronic storage, retrieval and transmission, and enables image enhancement and computer-assisted diagnosis.

X-rays cannot be easily focused, so the big challenge in creating a digital imager is to make the detector as large as the object to be imaged. For human medical diagnosis, the size must reach 17"x17", well beyond the capability of a conventional silicon chip. Previous approaches include image intensifier vacuum tubes and laser scanned storage phosphors. Hydrogenated amorphous silicon (a-Si:H) transistors and sensors, deposited on large glass sheets and patterned into devices by photolithography, provide a compact, fully solid state digital x-ray imager. These are manufactured with the same large area processing technology that is used for liquid crystal computer displays.

The flat panel x-ray detector is a pixel array, comprising up to 10 million pixels, with pixel size from 50 to 500 microns depending on the imaging application. The essential elements are a sensor that absorbs x-rays and creates a corresponding electric charge, a capacitor to store the charge, and the active matrix addressing that organizes the read-out of the signal to external electronics, which amplify, digitize and display the image. Each pixel contains one addressing transistor, and a single row of pixels is activated simultaneously by a common gate contact. The rows that make up the array are addressed in sequence to read out the whole image.

The imager technology is more than just transistors, and involves a combination of material science, semiconductor physics, imaging science, device processing and electronics design. A-Si:H transistors and sensors make the detectors possible. The a-Si:H transistor is fast enough to operate the detector at video rates. Its large (>10^9) on-to-off ratio is needed to hold charge on the pixel between readout events. Since the signal is stored on the sensor capacitance, low leakage is a must. Amorphous silicon has the important property of high resistance to radiation damage, in part because it has a disordered atomic structure.

Sensitive detection requires that the x-rays passing through an imaged object must be stopped in the thin film sensor. Detectors are best made from high atomic number materials. Even then, a thickness of 200-500 micron is required for the energies that are best suited to medical imaging. Since the a-Si:H sensor has neither of these attributes, a different approach is used in which the a-Si:H sensor detects light emitted by an adjacent phosphor layer, as shown in Figure 1. An incident x-ray excites a high-energy electron in the phosphor by the photoelectron effect. The electron loses energy by ionization, creating many low energy electron-hole pairs, which then recombine to emit visible light. This light emerges from the phosphor and is detected by the a-Si:H, which has excellent quantum efficiency at the 550nm emission wavelength of the two most common phosphors, CsI:Tl and GdO_2S_2:Tb.

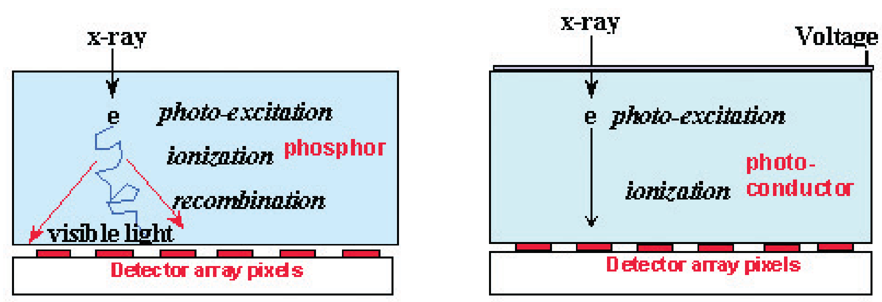


Figure 1. Diagram illustrating x-ray detection with a phosphor/sensor combination (left) and with an x-ray photoconductor (right).

Present flat-panel x-ray detectors operate in two basic modes, one of which is radiographic imaging, in which a single image is obtained, for example to identify a broken bone. Fluoroscopic imagers operate at video rates to monitor the continuous motion of internal organs or the progress of non-invasive surgical procedures. The same detectors are also used to inspect inanimate objects for security or quality control.

Most detectors now on the market use the phosphor/sensor combination, and several companies have made recent product introductions. General Electric offers several radiographic systems with image sensors made by Perkin Elmer, and Varian Medical Systems sells fluoroscopy detectors using arrays made by dpiX. Similar products have been introduced in Europe by Trixell and in Japan by Canon. Hologic offers radiographic systems using selenium sensors with a-Si:H transistor addressing.

The detector has gain in the sense that many charges are detected for each absorbed x-ray. The ionization within a semiconductor typically creates an electron-hole pair for each 5-10 eV of electron energy loss, so that a 100kV photon might develop 10,000 to 20,000 e-h pairs. However the rather complex detection process of the current technology reduces the measured sensitivity by a factor of 5-10. Furthermore, scattering in the phosphor tends to spread out the recombination light and therefore reduces the spatial resolution of the detector.

An alternative approach replaces the phosphor/sensor combination with a thick x-ray photoconductor, as illustrated on the right in *Figure 1*. The ionization charge is collected directly by the action of an applied electric field. There is minimal lateral diffusion of the charge to reduce the spatial resolution. The photoconductor must have a large mobility-lifetime product for the collection of charge in an applied field, and low leakage, low charge trapping and low temperature deposition are also essential.

Can materials be found with suitable properties? Amorphous selenium has proven effective, although the sensitivity is no greater than the phosphor detectors. More recently, we find that the semiconductors PbI_2 and, particularly, HgI_2 can achieve close to the theoretical sensitivity of one electron-hole pair detected for each 5 eV of x-ray energy absorbed, which gives nearly a 10-fold improvement.

Detector sensitivity is important because x-rays damage tissue, and it is essential that the required diagnostic information be obtained with the lowest x-ray dose. However, high sensitivity is only one component of the detector performance. The modulation transfer function (MTF) describes the spatial resolution of the array, and the detective quantum efficiency (DQE) describes how well the information content of the x-ray image is captured by the detector. The photoconductor generally gives an MTF that approaches the ideal for a pixel array. It has also proved possible to obtain a high DQE (>70%) with large x-ray dose, but the challenge is to maintain this at low dose, when electronic noise starts to dominate. This is particularly important in fluoroscopy applications where the image is obtained with less than 100 photons per pixel.

In the present detectors, the charge on a pixel is transferred through the a-Si:H transistor to a common address line where it is detected by an external amplifier. Large detectors have electronic noise values of 1000-2000e, which is roughly the charge detected from a single 100 kV x-ray in present systems.

The noise can be reduced by placing an amplifier in each pixel, taking advantage of the small input capacitance. We have demonstrated arrays of this type, using transistors made from laser recrystallized polycrystalline silicon rather than a-Si:H, because its larger mobility is better suited to amplifiers. A source follower provides a gain of about 10, which is enough to overcome the noise in the external amplifiers. Although this is a simple 3-transistor circuit, it opens the way to more complicated pixel electronics for added functionality. With the extra electronic devices on the pixel, there is no space for the sensor. The solution is a 3-dimensional structure in which the sensor is placed above the addressing electronics, separated by a thick passivation layer. The surface is coated completely with the a-Si:H sensor, which also follows the contours of the underlying electronics.

Flat panel x-ray detectors have only recently been introduced to the medical imaging market, but could prove to be the technology of choice for the next 100 years. Continued improvements such as those described here will allow lower patient dose, higher resolution imaging, and will extend the range of applications.

Bob Street is senior research fellow and manager of the Large Area Systems group at the Palo Alto Research Center.

SUBATOMIC ZOO, *from page 2*

should we spend the money finding out how many quarks there are when there are starving kids and people dying of AIDS?" Schwarz says. "I focus on showing them what some of the practical sides of physics are, medical applications and such. It's important to show them that. If you're going to teach them about balls rolling down hills, they are not likely to be interested."

Schwarz also emphasizes science policy in her class. Two years ago, she decided to have her students hold a debate. She broke them into six groups — taxpayers, local residents, an environmental protection group, American physicists, foreign physicists, and representatives from a high tech research and development company — and asked them to debate the pros and cons of building a particle collider in a certain town. They had to research their topic, pick a side, and present their findings to a group outside of the physics department who played the role of congressional representatives. "The groups did everything from researching the entire town, to geological surveys of land and water tables, to looking up electrical and water consumption at CERN," Schwarz said. "The exercise really gave them a chance to look at the politics of high energy physics."

Schwarz says that most important of all, she tries to give her students an understanding of how physics discoveries happen. "I don't only show them all of the right things, but the wrong things too," she said. "We talk about why the model of the atom without neutrons didn't work and how it didn't hold up. I try hard to bring the blend between theory and experiments into the classroom, to convey the idea that we don't always know where we're going. I want them to get an idea of the scientific process, at least in one field."

For more information on Tales from the Subatomic Zoo, see Cindy Schwarz's Web site: www.smallworldbooks.net.

The Physics of Football Goes Global

A series of local sports segments on the physics of football is finally going global. The series is the brainchild of University of Nebraska, Lincoln (UNL) professor Tim Gay, who completed 21 three-to-five-minute segments for the National Football League (NFL) this summer. The segments are slated to be aired over the next two years on an international sports program called "Blast!".

Gay first gained national recognition as an authority on football physics three years ago, when he began producing a series of 45-second spots for UNL's HuskerVision during football season [see *APS NEWS*, January 2000]. "I have a passion for physics and I enjoy teaching all aspects of it," Gay says. "It's the one thing besides football that I really love." For him, the two subjects are closely related. "Football is a manifestation of real-world physics, and it's something people can relate to."

The new NFL spots touch on the same topics as the original series for HuskerVision, employing concrete examples of how physics can be applied to various aspects of football. For instance, a wobbly pass experiences greater air resistance than a perfect spiral. Gay uses this phenomenon to impart knowledge about force, resistance and drag.

The new segments are also longer than the original spots, which were limited to about 60 seconds, enabling Gay to explore some of the basic physics concepts more deeply in the allotted time. Interviews with key players on their understanding of the physics of football add additional interest to the venture. "I'd say about three-quarters of the players were very interested in the subject and really wanted to know how to use that knowledge to improve their game," says Gay, which was gratifying. However, "The other one-quarter were rather belligerent. They didn't like having to think about physics."

Alas, while "Blast!" is shown in 190 different countries, the US isn't one of them, so American fans will have to wait two years for domestic distribution. The show is "essentially a propaganda tool of the NFL to try to win over the hearts of the teeming masses across the ocean and convince them of the merits of American football," Gay jokes.

He also has hopes of one day shooting a documentary with NFL films for the Discovery Channel, and might even get around to writing a book on the physics of football in the distant future. But for now, he's focusing on his laboratory experiments and teaching responsibilities. "Writing a book is a major commitment, so it's not something I want to do immediately."

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.

APS members are invited to join Friends of the CSWP

A moderated listserve for those interested in working more closely with the committee. Friends are invited to suggest topics/issues for discussion by the committee, speakers for invited sessions, names of well-qualified women physicists for fellowship/awards/prizes, etc. Friends will receive e-mail notices of Committee activities, reports, and will receive copies of the Gazette, the CSWP's newsletter.

Details at http://www.aps.org/educ/cswp/friends.html.

INSIDE BELTWAY, *from page 2*

legislative and executive branches. But for most of this year the artery has been filled to capacity.

More so than any past White House occupant, George W. Bush, the first president with an MBA, has operated in the mode of a true corporate CEO. That means top-down management, brooking no dissent and sharing as little information as possible with the outside world, including Congress. Administrators who do not toe the line are swiftly shown the door. More of this at the conclusion.

The Bush presidential style does not sit well with members of Congress in either party, who as the elected representatives of the people, demand due deference daily. When the President treats them with disdain—that happened during Clinton's first term—they get their hackles up and run with their own agenda.

Last February, the White House warned Congress that appropriations bills faced certain vetoes if they exceeded any of the presidential requests. Appropriators took a quick look at the numbers and immediately concluded that the Bush limits spelled certain congressional death.

Nonetheless, the House did the President's bidding and adopted a budget resolution that would hold total discretionary spending at the White House level of $759 billion. And that's where the action stalled. The appropriators could not get their bills to fit and essentially gave up trying, refusing to challenge a stalwart group of 50 of their arch-conservative House colleagues, who backed the President to the hilt.

The Senate took a pass on a budget resolution entirely and proceeded directly to its version of the appropriations bills. It succeeded in passing most of them without much rancor, but the finished products totaled $768 billion, $9 billion more than the President was willing to accept. End of story — well, almost.

Throughout the year, the White House has remained unrelenting in its opposition to spending increases for virtually anything other than Homeland Security and the military, often using agency heads as the messengers. Consider this one example.

As the House and Senate jointly moved ahead with an authorization bill that would set the NSF on a course to double its budget over a five-year period, the Foundation's director expressed the Administration's position this way in a letter that was sent to Senator Ron Wyden (D-OR) on September 16.

"While the Foundation appreciates the Committee's firm commitment to support fundamental research and science, technology, engineering, and mathematics (STEM) education,... we oppose S. 2817 in its current form....The amounts authorized ... do not conform to the Administration's FY 2003 Budget request...."

What was that request for research, you ask? You guessed it: zero increase, after transfers of activities from other agencies are taken into account.

Physicists Honored at November Unit Meetings

Nine physicists will be honored with APS prizes and awards at APS unit meetings being held this month. The 2002 Maxwell Prize, Award for Excellence in Plasma Physics, and the Rosenbluth Doctoral Thesis will be presented at the meeting of the APS Division of Plasma Physics, to be held November 11-15 in Orlando, Florida. The 2002 Fluid Dynamics Prize, Otto Laporte Award, and 2002 Acriros Award will be presented at the meeting of the APS Division of Fluid Dynamics, to be held November 24-26 in Dallas, Texas.

2002 James Clerk Maxwell Prize

Edward Frieman
Science Application International Corporation
University of California, San Diego

Citation: "For contributions to the theory of magnetically confined plasmas, including fundamental work on the formulation of the MHD Energy Principle and on the foundations of linear and nonlinear gyrokinetic theory essential to the analysis of micro-instabilities and transport."

Frieman is a plasma physicist with research interests that extend into other physical science fields. He was a professor at Princeton University for more than 25 years, after which he was employed by the federal government and in the private sector. Frieman earned his doctoral degree in physics in 1952 from Polytechnic Institute of Brooklyn, New York. Currently senior vice president, science/technology at SAIC, Frieman is also director emeritus of the Scripps Institution of Oceanography.

2002 Award for Excellence in Plasma Physics Research

Troy Carter
University of California, Los Angeles
Scott Hsu
California Institute of Technology
Hantao Ji
Princeton Plasma Physics Laboratory
Masaaki Yamada
Princeton Plasma Physics Laboratory

Citation: "For the experimental investigation of driven magnetic reconnection in a laboratory plasma. In this work, careful diagnostic studies of the current sheet structure, dynamics and associated wave activity provide a comprehensive picture of the reconnection process."

Carter received B.S. degrees in physics and in nuclear engineering from North Carolina State University in 1995. He received his PhD in astrophysical sciences in 2001 from Princeton University. For his dissertation, he performed an experimental study of turbulence in the current sheet of the Magnetic Reconnection Experiment. This work provided the first experimental evidence of the operation of the lower-hybrid drift instability in a laboratory current sheet. Carter was awarded a DOE Magnetic Fusion Energy Postdoctoral Fellowship, which he took to UCLA to pursue experimental studies of turbulence and transport in magnetized plasmas. He is now continuing this work as an assistant professor in the Department of Physics and Astronomy at UCLA.

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Hsu received his B.S. degree in electrical engineering from the University of California at Los Angeles in 1993. He received his PhD in plasma physics from Princeton University in January, 2000, having investigated ion heating and acceleration during magnetic reconnection on the Magnetic Reconnection Experiment (MRX). Subsequently, he went to Caltech to work on laboratory plasma experiments designed to study magnetic helicity injection during spheromak formation. In December, 2002, Hsu will join the P-24 Plasma Physics Group at Los Alamos National Laboratory and continue pursuing research in basic experimental plasma science related to fusion energy and plasma astrophysics.

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Born in China, Ji received a B.S. degree in physics from Ehime University (Japan) in 1985, and a PhD in physics from University of Tokyo (Japan) in 1990. After working on the Large Helical Device (LHD) project at National Institute for Fusion Science (Japan), he worked on the Madison Symmetric Torus (MST) at University of Wisconsin, Madison, and since 1995 he has been conducting research on the Magnetic Reconnection Experiment (MRX) at Princeton Plasma Physics Laboratory. Currently, his research interests include physics of magnetic reconnection, magnetorotational instability and MHD surface waves in liquid gallium, dynamo effects and conservation of magnetic helicity in self-organizing plasmas, turbulence and associated transport processes.

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Yamada is a Distinguished Laboratory Research Fellow at Princeton Plasma Physics Laboratory, and heads the MRX research program. He graduated from University of Illinois with PhD in physics in 1973. In that same year he joined PPPL as a postdoctoral fellow. He became the head of the Q-1 research group in 1977 and carried out many basic plasma physics experiments. During 1978-1988, he headed the research effort on the spheromak, then a new concept for fusion, utilizing the S-1 device. Yamada pioneered the MRX program at Princeton to explore the fundamental physics of magnetic reconnection, one of the most difficult and fundamental problems in plasma physics that has been under intense theoretical discussion for many decades. Currently the MRX group is focusing it's work on fast reconnection in collision free plasmas.

2002 Marshall N. Rosenbluth Outstanding Doctoral Thesis Award

Mayya Tokman
University of California, Berkeley

Citation: "For the development of exponential propagation methods for 3-D MHD simulations and for their application to the solar corona, giving new understanding of observed features of coronal mass ejections."

Tokman began her undergraduate education at Baku State University in Azerbaijan, a former republic of the Soviet Union. After immigrating to the US, she completed her B.S. in applied mathematics with specialization in computing at the University of California, Los Angeles. In 1995 she became a graduate student in the applied mathematics department at the California Institute of Technology. Currently she holds the position of visiting assistant professor in the mathematics department at UCB. Her research interests include mathematical modeling, numerical methods and computational science. She is particularly interested in developing effective models of physical phenomena which exhibit multiscale behavior.

2002 Fluid Dynamics Prize

Gary Leal
University of California, Santa Barbara

Citation: "For his extensive use of a blend of modern analysis, innovative numerical computation, and experiments to elucidate phenomena in classical and polymer fluid dynamics."

Leal attended graduate school at Stanford University, where he carried out his PhD research under the guidance of Andreas Acrivos, after competing his degree in 1969 and two years of postdoctoral work, he joined the chemical engineering faculty at Caltech (1970), where he remained until moving to UCSB in 1989. At UCSB, he served as department chair in chemical engineering for nine years. In addition to his normal professional duties, he is currently one of the two editors of *Physics of Fluids*.

2002 Otto LaPorte Award

Andrea Prosperetti
Johns Hopkins University

Citation: "For breakthroughs in the theory of multiphase flows, the dynamics of bubble oscillations, underwater sound, and free-surface flows and for providing elegant explanations of paradoxial phenomena in these fields."

Prosperetti received his PhD in engineering science at Caltech in 1974. He was a member of the physics faculty from 1974 to 1985 at the University of Milan. Since 1998 Prosperetti has been Berkhoff Professor of Applied Physics (part-time) at University of Twente (The Netherlands) and since 1994 the Charles A. Miller Jr. Professor at John Hopkins. His research interests include fluid-solid disperse multiphase flow, gas-liquid multiphase flow, bubble dynamics and cavitation, free surface flows, computational fluid mechanics and acoustics

2002 Andreas Acrivos Award

Wade Schoppa
Shell

Citation: "For his studies on the generation of coherent structure in near-wall turbulence."

Biographical information not available at press time.

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What Produces a Thriving Undergraduate Physics Program?

By Ken Krane

During the 1990s, the number of baccalaureate physics degrees awarded annually in the US dropped by about 25%, from about 5000 per year in 1990 to about 3800 per year in 1999. Simultaneously, the *total* number of bachelor's degrees awarded was *increasing*, so the fraction of physics degrees fell from 0.5% of total bachelor's degrees to 0.3%. Although there is evidence of a small increase in physics baccalaureate degrees in the past two years, it is not clear that this increase represents a trend and even less clear that it can be sustained to reverse the declines of the past decade. The decrease in undergraduate physics degrees occurred at all types of institutions, although it was especially severe at M.S. and Ph.D.-granting institutions (down 33%) compared with 4-year colleges (down 17%).

What is the cause of this decline? There appears to be no definitive answer, but it is clear that the physics environment has changed. These changes include: an increasingly multidisciplinary character of the physics profession (biophysics, materials physics, computational physics, etc.) which is not always well represented in the undergraduate curriculum; an increasingly diverse student body, representing a greater variety of backgrounds and motivations; mismatches, identified by physics education research, between what we teach and what our students learn; and a growing perception among students that the biological sciences are now "where the action is" and that physics is increasingly disconnected from societal needs.

Nevertheless, there are a number of undergraduate programs that have not only avoided sharing the national decline in numbers of majors, but in some cases have even been able to grow and thrive in this new environment. The National Task Force on Undergraduate Physics (NTFUP), an 11-member panel created in 1999 by APS, AAPT, and AIP, has carried out a study of such departments to determine what factors are responsible for their success. Information about the Task Force's membership and projects can be found under "Programs" through the AAPT web site (www.aapt.org).

The task force has identified a number of features that should characterize a thriving undergraduate physics program: a sufficient number of majors, including significant representation of women and minorities; high faculty and student morale; success in placing graduates into graduate school and the workforce; the respect of the administration and other departments on campus; involvement of a majority of the faculty in undergraduate education; inclusion of students and staff on the departmental team; and efforts to promote excellence in K-12 education.

With the support of the ExxonMobil Foundation, NTFUP carried out site visits to 23 departments where there was indication of success in some aspects of the undergraduate program. These departments were selected primarily, but not entirely, on the basis of undergraduate enrollments in the physics major. The Ph.D.-granting institutions we visited typically award more than 20 (and some many more) bachelor's degrees per year (compared with the national average of about 10). The four-year colleges visited generally produced more than 10 graduates per year, far exceeding the national average of about 3. The sites were located across the US About 1/3 were public and private Ph.D. — granting institutions, about 1/3 were private four-year colleges, and the remaining 1/3 were primarily public bachelor's-and master's-granting institutions.

"There are a number of undergraduate programs that have not only avoided sharing the national decline in numbers of majors, but in some cases have even been able to grow and thrive in this new environment."

At the invitation of the department Chair, a three-person team visited each of these campuses for 1-1.5 days and met with students, faculty, staff and administrators. Each visiting team was led by a member of the NTFUP and included two other members of the physics community. Altogether about 70 physics faculty members participated in the site visits. The department prepared in advance a response to a questionnaire designed to provide background information for the visit. Rather than being a comprehensive review of the department or even of its undergraduate programs, the site visit was designed to learn about the successful aspects of the program and the local climate that created and sustained the program. Each site visit team produced a written confidential report that was circulated only to the NTFUP members and to the department. Concise summaries of many of these reports have been developed into a series of publicly available "case studies" that highlight notable activities in each department. These case studies are available through the Task Force web site.

We recognize that visits to 3% of the physics baccalaureate programs in the US will not necessarily produce results that are characteristic of the entire community. So for comparison purposes, NTFUP also conducted a survey (with the assistance of the AIP Statistical Research Center) to gather corresponding data on undergraduate physics programs in the US Information covered by the survey includes curricula, courses, recruiting, alumni contacts, and reform efforts. The survey form was sent to all 759 baccalaureate-granting physics programs in the US, and we received an impressive 74% response (561 departments). Analysis of the results of the survey is underway, and the results will be released in the fall of 2002.

What has been learned from the site visits? A number of common themes consistently emerged for the thriving departments even though they covered an enormous range of sizes and types of institution. These themes included:

(1) A widespread attitude among the faculty that the department has the primary responsibility for maintaining or improving the undergraduate program. That is, rather than complain about the lack of students, money, space, administrative support, etc., the department initiated reform efforts in areas that it identified as most in need of change.

(2) A clear understanding and appreciation of the department's mission and its relationship to the setting and mission of the university.

(3) Knowledge of the department's students, and focused efforts to develop a sense of community among the students.

(4) Apparent evidence of the high value placed on undergraduate programs.

(5) Strong and sustained leadership.

These common themes were expressed through an enormous variety of specific activities and programs: recruiting of pre-enrolled and enrolled students (examples of the latter being students enrolled in the calculus-based introductory course); a range of flexible curricula for majors, such as degrees with physics-related concentrations (for example, biophysics or geophysics), dual degrees, 3/2 engineering degrees, and specialized pre-professional degrees (such as those targeted at students preparing for careers in secondary teaching, medicine, law, or business); one-credit orientation or "introduction to physics" courses for first-year majors; undergraduate study rooms or lounges, along with keys for after-hours access to the physics building; coherent and dedicated advising; active SPS chapters; open access to (and warm reception by) faculty *and* the department head, including the opportunity for the department to obtain feedback from students on any aspect of the undergraduate program; undergraduate research; and employment of undergraduates as teaching assistants.

Examples of especially noteworthy programs include:

• Lawrence University conducts a national recruitment for a February/March weekend physics workshop for high school seniors. Between 60 and 80 students apply to attend, about 30 are invited, and about 1/3 choose to matriculate at Lawrence. The University pays all costs for the workshop ($15-18K).

• Colorado School of Mines holds a Summer Field Session for all of its students for 6 weeks at the end of the sophomore year. Supervised by 4 or 5 faculty, the physics program includes career information, an introduction to research programs in the department, experience using machine shop tools and vacuum systems, electronics, and computer software packages.

• Rutgers University has developed a multitrack degree program, which has helped it to grow to now award about 40 degrees per year. About 1/3 of its students choose the traditional physics track, about 1/3 choose an applied or engineering track, and about 1/3 choose a general track that serves students in prelaw, premedicine, or pre-service teaching.

• At the University of Wisconsin—La Crosse, the physics program granted an average of one degree every two years in 1990. Through curricular reforms, aggressive recruiting, and a 3/2 engineering program, they have grown to award an average of 15 degrees per year.

• At the University of Illinois, the department undertook a complete overhaul of the introductory courses, applying results from physics education research, improving TA training, and introducing enhancement or "companion" courses targeted at specific audiences (new majors, at-risk students, students seeking additional challenges).

• At Reed College, the required junior-year qualifying exam and senior year thesis serve to build a coherent program starting in the first year and to focus the energies of faculty and students in collaborating to reach a specific set of goals.

It is also worth commenting on a number of other items that did not seem to be important in promoting a thriving undergraduate physics program with many majors.

(1) While advising was important, both highly centralized advising and advising distributed among all faculty appeared to work equally well.

(2) The type of recruiting that was effective depended heavily on the institution. For example, for a few departments, pre-college recruitment was an important tool, while for many others it was of little benefit.

(3) While the recruiting programs and supportive community atmosphere of these departments clearly had an impact on the total number of majors, it had no apparent effect on the fraction of majors who were women or ethnic minorities. Those fractions in the site visit departments were consistent with the averages for all US physics departments.

(4) Innovations in the introductory courses based on physics education research had no apparent effect on the number of physics majors, although they may have had other benefits. The site visit teams did not attempt to measure student learning or conceptual understanding.

Ken Krane

A report discussing detailed findings from the site visit program and the national survey will be available for distribution to the physics community in the fall of 2002.

In addition to these programs, the task force has undertaken responsibility for a number of other activities: an invited meeting (in the fall of 2001) of the department chairs of a small number of leading research universities to discuss undergraduate programs; collaboration in a similar program of site visits to physics programs at two-year colleges; a conference on the calculus-based introductory course, planned for the 2002-2003 academic year; oversight of the AAPT/APS/AAS annual New Faculty Workshop program.

Moreover, the task force is very concerned that our site visit program did not produce any significant insights on enhancing the number of minority physics majors. As a result, we are planning to focus our efforts on this topic at our December 2002 meeting, and we expect follow-up programs to result from this meeting.

Participating in the site visit program, one gains a renewed appreciation for the overall health and strength of our undergraduate programs and for the commitment of many faculty to the vitality of undergraduate physics education. We trust that this study and the collection of best practices assembled in the report will provide physics departments with a guide for improving their undergraduate programs. The task force stands prepared to assist those departments with their efforts, and we invite you to contact the task force chair (Robert Hilborn,rchilborn@amherst.edu) or its entire membership (ntfup@aapt.org) to discuss our programs in general or their possible application to your department.

Ken Krane is Professor of Physics at Oregon State University. This report was prepared with the assistance of many members of the Task Force, with particular contributions from Robert Hilborn, Ruth Howes, and Carl Wieman.