APS NEWS

January 2003
Volume 12, No. 1

A Publication of The American Physical Society http://www.aps.org/apsnews

APS Expands and Updates Ethics and Professional Conduct Guidelines for Physicists

Prompted by recent highly publicized episodes of misconduct in physics, the APS has updated and expanded its professional ethics guidelines. The changes, adopted November 10, 2002, at the APS Council meeting, clarify the roles and responsibilities of coauthors, emphasize the importance of professional ethics education in the training of scientists, and suggest that all research institutions, regardless of funding sources, adopt policies consistent with the Federal Policy on Research Misconduct.

"We shall make a concerted effort over the next few years to better educate physicists in appropriate professional ethics, standards and practices," said APS President William Brinkman of the Council's action. "We also want to strongly encourage all institutions involved in physics research to define their policy and the processes that should be followed if fraud or other misconduct is detected. I feel that the revisions we have made to the APS guidelines are a step in the right direction."

The APS Council has adopted new Guidelines on the Responsibilities of Coauthors and Collaborators. The guidelines state that "all coauthors share some degree of responsibility for any paper they coauthor" and that "some coauthors have responsibility for the entire paper. These include, for example, coauthors who are accountable for the integrity of the critical data reported in the paper, carry out the analysis, write the manuscript, present major findings at

See CONDUCT *on page 7*

Online Resources:

The APS Revised Guidelines on Professional Conduct can be found at **http://www.aps.org/statements/02.2.html**

The new APS Statement on Policies for Handling Allegations of Research Misconduct can be found at **http://www.aps.org/statements/02.3.html**

The new APS Statement on Improving Education for Professional Ethics, Standards and Practices can be found at **http://www.aps.org/statements/02.4.html**

The Federal Policy on Research Misconduct can be found at **http://www.ostp.gov/html/001207_3.html**

New York Area Fellows Convene

Photo by Barbara Hicks

APS Fellows in the New York area gathered in November at the CUNY Graduate Center for a reception hosted by then President-elect Myriam Sarachik. In addition to refreshments and conversation, the evening featured a program chaired by then APS President Bill Brinkman, at which Executive Officer Judy Franz and Director of Education Fred Stein also spoke. Shown here are (l to r): Cheng-Hsuan Chen (Bell Labs), Donald Monroe (Agere Systems) and Alice White (Bell Labs).

DPP Meeting Features High Magnetic Fields, Lab-Based Astrophysical Jets

Where can you find the strongest magnetic fields on Earth? Why do galactic nuclei spit out vast plumes of hot material into space? How can x-rays squeeze fuel capsules to generate energy? How can the turbulent flow of a plasma make itself stable and what does that have to do with the patterns on Jupiter? These and many other questions were addressed at the annual meeting of the APS Division of Plasma Physics (DPP), held from November 11-15, 2002 in Orlando, Florida. Approximately 1600 papers were delivered.

Astrophysical Jets in the Lab. Many astronomical objects, from galactic nuclei to black holes surrounded by accretion disks, emit very long plumes of plasma, called astrophysical jets. In a new laboratory plasma experiment, Caltech researchers have shown how magnetic forces can create these jets. Magnetic forces squeeze the plasma into a narrow plume and eject this plume along the axis, forming a jet-like structure. These results should help to shed light on the long-standing problem of how jets are formed. In the experiment, up to 150 kilo-Amperes of electric current are run through a hydrogen plasma inside a cylindrical metal chamber the size of a large closet. Some of the jet-like plumes show a spiral structure similar to what is

See DPP MEETING *on page 6*

Microfluidics, Jovian Climate Change Highlight DFD Meeting

Recent advances in microfluidics and the use of vortex dynamics to predict an impending global climate change for the planet Jupiter were among the highlights of the annual meeting of the APS Division of Fluid Dynamics (DFD), held November 24-26 at Southern Methodist University and the University of Texas at Austin. More than 950 contributed papers were presented, in addition to two honor lectures and eight invited lectures. Also featured was the annual Gallery of Fluid Motion, in which researchers submit aesthetically pleasing, insightful displays of still pictures, computer graphics, and video clips of computational and experimental fluid dynamics.

A fundamental understanding of thermocapillary flow on homogeneous and chemically patterned surfaces has led to the development of miniaturized automated systems for transporting small liquid volumes through networked arrays, which are rapidly expanding diagnostic capabilities in medicine, genomic research and materials science. Princeton University's Sandra Troian described her work on such microfluidic devices, which combine micromechanical and electrokinetic techniques for metering flow in closed channels. Her team has demonstrated that programmable thermal maps can be used in conjunction with chemical substrate patterning to modulate thermocapillary flow. This method provides electronic control over the direction, flow rate, mixing, splitting and trapping of discrete droplets or continuous streams.

Kenny Breuer of Brown University discussed the mechanics of fluids at the micron and submicron scale, which are critical to the widespread growth of microengineering and the development of a new generation of micron- and nanometer-scale diagnostic techniques. He identified several remaining chal-

See DFD MEETING *page 4*

Philadelphia Will Host 2003 APS April Meeting

The "City of Brotherly Love" will host as many as 1500 physicists at the 2003 APS April meeting, to be held April 5-8 in Philadelphia. For the first time, the meeting will coincide with the divisional meeting of the Division of Particles and Fields, and will therefore feature a large complement of invited and contributed sessions devoted to high-energy physics.

In addition, attendees will be drawn from a wide range of other research areas. Besides DPF, APS units represented include the Divisions of Astrophysics, Nuclear Physics, Plasma Physics and Computational Physics; the Forums on Education, Physics and Society, International Affairs, History of Physics and Graduate Student Affairs; and the Topical Groups on Few-Body Systems, Precision Measurement and Fundamental Constants, Gravitation, Plasma Astrophysics, and Hadronic Physics.

The scientific program will feature three plenary sessions and approximately 45 invited sessions — including talks by the most recent recipients of the Nobel Prize in Physics—as well as more than 100 contributed and poster sessions. There will also be a special public lecture by Harvard University's Dudley Herschbach on Benjamin Franklin's

See PHILADELPHIA *on page 7*

APS Council Approves Statement Protesting Boycott of Israeli Scientists

In response to recent calls initiated by some European academics to boycott Israeli scientists and the Israeli scientific community, the APS Council has passed a statement reaffirming its "commitment to maintaining open dialogue and promoting cooperation among scientists throughout the world. The APS strongly opposes attempts to isolate any scientific community."

The Society's position is based on a November 12, 1989, Council statement on the international nature of physics and international cooperation, the preamble of which states: "Science belongs to all humanity and transcends national boundaries. As in the past, science can serve as a bridge for mutual understanding across political and ideological divisions and as a vehicle for the enhancement of peace. In particular, APS believes that it is important at this time to strive for more open dialogue among scientists to enhance international cooperation."

The APS also endorses the statement issued on August 27, 2002 by the International Council for Science (ICSU), in support of the Israeli scientific community. That action was taken in response to the dismissal of two Israeli scholars from the editorial boards of two U.K. journals, as well as other attempts to foster an academic boycott of Israeli scientists, events the ICSU deemed "a flagrant breach" of its long-held principle of the universality of science. "Intellectual communities worldwide are in the business of fostering international understanding and cooperation, not of penalizing each other for the shortcomings of their government," the statement concluded.

The full text of the ICSU statement can be found at http://www.icsu.org/Library/Central/Statem/israeli-schol.html.

Highlights

This Month in Physics History

Circa January 1961: Lorenz and the Butterfly Effect

To the average layperson, the concept of chaos brings to mind images of complete randomness. Yet to scientists, it denotes stochastic behavior occurring in a deterministic system: namely, systems that are so sensitive to measurement that their output appears random, even though there is an underlying order. This seemingly paradoxical viewpoint was born when a mathematician turned meteorologist named Edward Lorenz made a serendipitous discovery that subsequently spawned the modern field of chaos theory and changed forever the way we look at nonlinear systems like the weather.

Even as a boy, Lorenz was fascinated by the weather, monitoring the thermometer and recording highs and lows outside his parents' house in West Hartford, Connecticut. He was also interested in mathematics, often solving puzzles with his father. After graduating from Dartmouth College in 1938, Lorenz planned to go into math, but World War II intervened: he served as a weather forecaster in the Army Air Corps. Afterwards, he decided to stick with meteorology, making an early name for himself by publishing on such topics as the general circulation of the atmosphere.

But he was particularly intrigued by weather prediction, which was still largely intuitive guesswork, despite the assistance of scientific instrumentation. With the advent of computers, Lorenz saw the chance to combine mathematics and meteorology. He set out to construct a mathematical model of the weather using a set of differential equations representing changes in temperature, pressure, wind velocity, and the like. By the early 1960s, Lorenz had managed to create a skeleton of a weather system from a handful (12) of differential equations. He kept a continuous simulation running on an extremely primitive computer, which would produce a day's worth of virtual weather every minute. The system was quite successful at producing data that resembled naturally occurring weather patterns — nothing ever happened the same way twice, but there was clearly an underlying order.

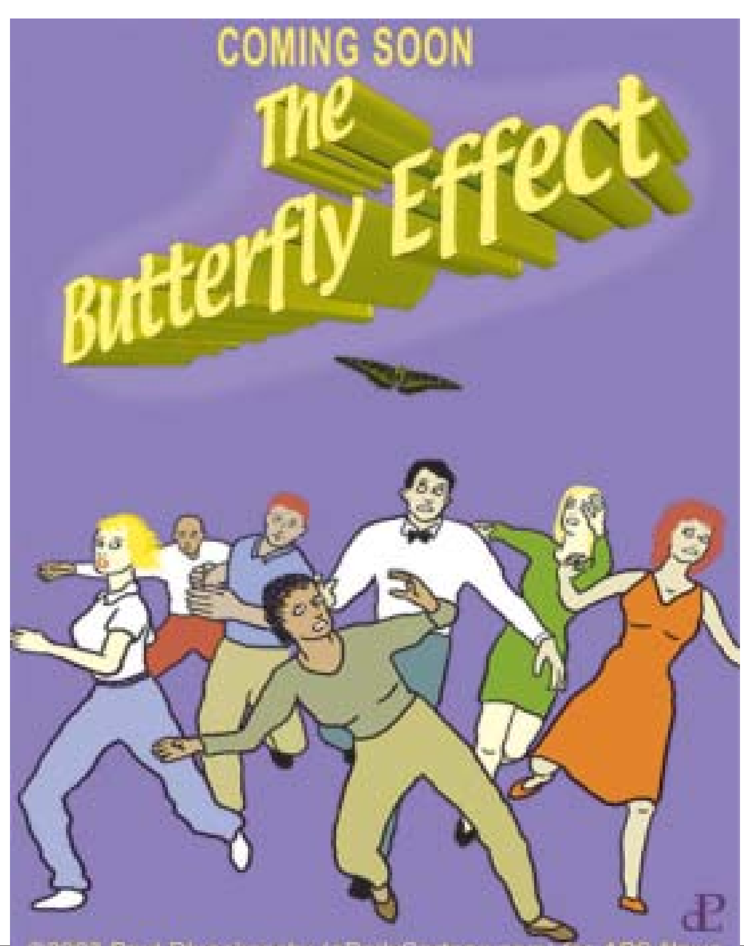
One day in the winter of 1961, Lorenz wanted to examine one particular sequence at greater length, but he took a shortcut. Instead of starting the whole run over, he started midway through, typing the numbers straight from the earlier printout to give the machine its initial conditions. Then he walked down the hall for a cup of coffee, and when he returned an hour later, he found an unexpected result. Instead of exactly duplicating the earlier run, the new printout showed the virtual weather diverging so rapidly from the previous pattern that, within just a few virtual "months", all resemblance between the two had disappeared.

At first Lorenz assumed that a vacuum tube had gone bad in his computer, a Royal McBee, which was extremely slow and crude by today's standards. Much to his surprise, there had been no malfunction. The problem lay in the numbers he had typed. Six decimal places were stored in the computer's memory: *.506127*. To save space on the printout, only three appeared: *.506*. Lorenz had entered the shorter, rounded-off numbers assuming that the difference—one part in a thousand—was inconsequential.

It seemed a reasonable assumption. Scientists are often taught that small initial perturbations lead to small changes in behavior in any given physical system, and even today, temperature is not routinely measured within one part in a thousand. Lorenz's computer used a purely deterministic system of equations, so that given a particular starting point, the "weather" would unfold exactly the same way each time, while a slightly different starting point would cause the weather to unfold in a slightly different way. Lorenz figured a small numerical variation was similar to a small puff of wind, unlikely to significantly impact important, large-scale features of the weather.

Yet in Lorenz's particular system of equations, such small errors proved catastrophic. Today, this phenomenon is known as sensitive dependence on initial conditions. Lorenz subsequently dubbed his discovery "the butterfly effect": the nonlinear equations that govern the weather have such an incredible sensitivity to initial conditions, that a butterfly flapping its wings in Brazil could set off a tornado in Texas. And he concluded that long-range weather forecasting was doomed.

In the past, such observed behavior—namely, random fluctuations coming from what should be a completely deterministic set of equations — had been discarded as simply an error in calculation. Lorenz was the first to recognize this erratic behavior as something other than error; what he saw was undeniable order, born out of randomness. Not only was this the first clear demonstration of sensitive dependence on initial conditions, but Lorenz showed that this occurred in a simple but physically relevant model.



Lorenz then created a new system with three nonlinear differential equations, a reduced model of convection known as the "Lorenz Attractor." He hypothesized that the graph he created to model the motion would either reach equilibrium and stop, or create a loop that would eventually be reformed and retraced, indicating a repeating pattern. Instead, his map displayed an infinite complexity, always staying with certain bounds, but never repeating itself either. It traced a distinctive double-spiral shape, aptly resembling a butterfly with its two wings.

Since Lorenz's discovery, computer modeling has succeeded in changing the weather business from an art into a science, yet beyond two or three days, even the world's best forecasts are still speculative, and beyond a week, they are worthless. Such is the paradox that is chaos.

Further Reading:

Gleick, James. *Chaos: Making a New Science*, Viking Penguin, 1987.

Members in the Media

"That could screw up things more than anything else. Inspectors need to be confident and experienced. You need enough information in the hands of inspectors to nail the Iraqis or show they are compliant."
—David Albright, Institute for Science and International Security, on why the weapons inspectors in Iraq need to be experienced, ABCNews.com, November 18, 2002

✶✶✶

"I think we would have liked if Batlogg had stood up and said, `I put my name on those papers and it was the worst judgment of my life,' but he didn't do that."
—Douglas Stone, Yale University, on the responsibility of Bertram Batlogg in the Schön affair, Boston Globe, November 19, 2002

✶✶✶

"At least we can do no worse than it's been for the last 100 years."
—Richard Steiner, NIST, on new ways to define the kilogram, Dallas Morning News, November 18, 2002

✶✶✶

"That is when I began to suspect there was some kind of underlying principle operating here. Ultimately, it all comes from Heisenberg's Uncertainty Principle."
—Julio Gea-Banacloche, University of Arkansas, on fundamental limits on the smallness of quantum computers, Cosmiverse.com, November 21, 2002

✶✶✶

"It's the heroin pusher's approach to marketing."
—Martin Blume, American Physical Society, on giving data away free to lure customers in, Washington Post, November 21, 2002

✶✶✶

"Accomplishments of the program during the past few decades have been truly remarkable."
—Richard Hazeltine, University of Texas at Austin, on progress in fusion research, MSNBC, November 25, 2002

✶✶✶

"If you say let's integrate all the codes over all the timescales, there's really no roadmap for doing that. Our approach deals with this in (pairs of problems) instead."
—Jill Dahlburg, General Atomics, on the problem of simulating nuclear fusion on a computer, UPI, November 25, 2002

✶✶✶

"When we are done with this, someone else will commercialize fusion. (The result) should be safe and environmentally attractive, and extrapolate to competitive costs in the U.S. market."
—Robert Goldston, Princeton University, on a proposed demonstration project for fusion power, UPI, November 25, 2002

APS NEWS

Series II, Vol. 12, No. 1
January 2003

Coden: ANWSEN ISSN: 1058-8132

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

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

Letters to the editor are welcomed from the membership. Letters must be signed and should include an address and daytime telephone number. The APS reserves the right to select and to edit for length or clarity. All correspondence regarding *APS News* should be directed to: Editor, *APS News*, One Physics Ellipse, College Park, MD 20749-3844, E-mail: letters@aps.org.

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

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

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

Sarachik Outlines Priorities for Society in 2003

Editor's Note: *Myriam Sarachik (City College of New York) assumed the APS presidency on January 1, 2003. In an interview with* ***APS NEWS****, she discusses her priorities and concerns for the Society during her presidential tenure and beyond.*

Q: In some respects, the APS is operating in a vastly changed national and global context since the terrorist attacks of 2001. Has this impacted the Society's activities and priorities?

A: Despite how much the world has changed since September 11, I think the fundamental mission of APS remains the same. For example, we still need to continue to make the case for the importance of science in general, and for the physical sciences in particular. Physics is a fundamental science. It drives and informs many of the advances in other fields, for example, medical instrumentation such as MRIs, X-rays, CT scans. The technology that has shaped our world originated in fundamental discoveries made by physicists in their quest to understand how nature works.

So we have to persuade the public and our policy makers that continued investment in science — including fundamental research — is absolutely essential for the future of the nation. The APS Washington office has been increasingly effective in making the case. And it's also gratifying that we've succeeded in involving more of our members in these efforts. We hope very much to increase that participation further.

Q: One of the issues you cited in your candidate's statement was the increased specialization of physics, and the need for more unity in the field. Why is this so important?

A: That has been one of my serious concerns, because the field has divided itself into smaller and smaller subgroups that often don't communicate with each other very well. But we're all physicists with common backgrounds and interests, regardless of subfield and regardless of whether we work in industry, academia or government labs. I would dearly love to establish better communication between us and re-establish a sense of community. Communication is particularly important since so much of today's exciting research is at the interface between disciplines, for example, biology and physics.

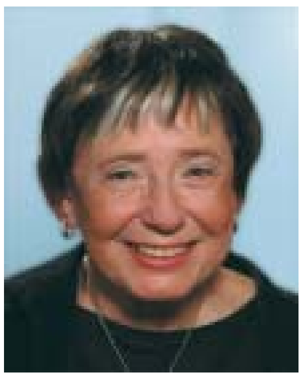
The APS recent workshop on opportunities for physicists in biology was extremely successful. The Society also helped establish a consortium of scientific societies to work to increase science funding which has met with considerable success. There is great strength in unity. If the physics community were more united, and united in turn with all the sciences, including the life sciences, we would represent a very strong force indeed.

Q: What are some of the prevailing current issues that require the Society's attention?

A: There are a number of issues that have come up recently. One issue concerns several recent instances of scientific fraud, which many of us thought could not happen in our field. These have prompted a careful re-examination and strengthening of our guidelines for professional conduct (See story, page 1). Another issue is that our foreign students and colleagues are now encountering a great deal more difficulty in obtaining visas in a timely way. This has become a very serious problem for many of our graduate programs. The APS Office of International Affairs has labored very hard on this, but it's been difficult to get a handle on the problem. It's not clear how to access the people who are making the decisions, especially in light of changed circumstances and with a new administration that espouses a very different philosophy from the previous administration.

A third issue just on the horizon is proposed new rules to classify the results of scientific research. These rules will affect the exchange of information, which we all recognize is essential for scientific progress. There is a move towards categorizing some work as sensitive but not classified, for example. What does that mean? What are the consequences?

Who's going to make the decisions, and how is that going to be handled? I think this is going to be a big issue for us. We strongly believe that communication between scientists everywhere should serve as a bridge between us. But we do live in a very altered world. I think the threat of terrorism and terrorist activities is something we must take very seriously. The APS has formed a Task Force on Countering Terrorism to survey the current activities in this area and to help identify problems for which physicists can find solutions (See story on page 5). We need to inform our government leaders how we can help them deal with these problems.



Myriam Sarachik

Q: There are also ongoing concerns about the future workforce in physics, particularly the need to attract more young people to the field.

A: The APS has been quite active in this area through numerous initiatives in the area of education. But more needs to be done. We need to spread the message that physics is very exciting. It's a fundamental science that drives many other things. It is particularly important that we continue to apply resources to our ongoing efforts to involve women and minorities in physics.

There has been some progress regarding women but again, more needs to be done. And we need to redouble our efforts to interest members of minority groups to study physics and to join our ranks. We've been relatively unsuccessful at that.

Q: As a successful woman in physics, when did you first become interested in the subject, and what made you decide to make it your career? And what advice would you give to other women who would like to study physics?

A: To be honest, I don't really know what drew me. I was interested in a number of things, and I was trying to choose between them: music, languages, math, and literature. Physics was the toughest subject I had ever tried to do, and in the beginning I had a great deal of difficulty with it. It was interesting and it was a challenge, and I decided that was what I was going to do in my life. It took some time, and hard work, but eventually I did very well.

My advice to other women is: if you like it, don't let anything or anyone talk you out of it. But, be prepared to work hard.

Q: You are only the third woman to become APS president in the Society's 100-plus-year-history, about to be followed by a fourth, Helen Quinn, in 2004. You've been involved with the APS for many years, but why did you decide to take on the presidency, with its substantial time commitment?

A: It is a big commitment but I felt that it was an important thing

See SARACHIK *on page 7*

Viewpoint...

Perspectives on Ethics and Validity in Science

By R. Stephen Berry

Science and the knowledge it produces have a special, unique quality in the body of human experience. A characteristic of this uniqueness is the capacity of science to provide reliable quantitative predictions of phenomena, within its own domain. No other aspect of human experience has this capability. But this predictive power is the consequence of the way scientific studies evolve. The validation processes of the scientific enterprise are themselves unique and are the basis of the predictive powers of science.

Science advances by a kind of trial-and-error activity, guided by past observations and the interpretations — theories, if you will — of the phenomena that yielded those observations. Foremost is the establishment of the validity of the result. A measurement of a quantity that has been predicted by a very well-established theory is unlikely to stimulate experiments to repeat and validate that result. For many years the theoretical methods available to compute properties of simple atoms were accepted to be capable of generating more accurate values than the experiments that could measure the same properties. But it was useful for investigators to improve the experimental methods and continue to measure the properties.

At the opposite extreme are results that challenge established findings, whether experimental or theoretical. When a new experiment yields a value of a fundamental constant of nature that lies three standard deviations outside the range of previously measured values, people take notice. First, they scrutinize the way the new measurement was made, and if it seems without apparent error, they are likely to repeat the new measurement and to find other ways to measure the quantity in question. There are well-recorded instances of a set of apparently consistent measurements being superceded by such an "outlier" that was subsequently validated.

Another instance—the concept of continental drift, or plate tectonics—illustrates how science treats iconoclastic ideas, far outside accepted dogma, that could not be tested rigorously with the means available when the idea was first proposed, even though it was eventually shown to be correct. Without validation, scientific skepticism determined the fate of the concept until the key measurements could be made.

On the other hand, there are also clear instances in which the surprising result was shown to be erroneous. The most obvious recent example is the purported achievement of cold fusion. Its potential importance, had it been valid, helped stimulate many researchers to examine the work and, in a matter of months, to discredit it and show how the erroneous results came about.

In between are results that are potentially quite important and not strikingly inconsistent with accepted ideas. One is the recent report that element 118 had been observed, a result expected to be difficult to obtain, but consistent with ideas of nuclear structure. Such reports are certain to be examined critically, but not with the alacrity of a report of cold fusion. The self correction process of science inevitably and inexorably brings anyone who wants to build on previous work to do something that will test the correction of that work. While it may be a long time before anything appears to challenge the results, as soon as any apparent inconsistency arises, the challenge inevitably begins. This continual validation and insistence on consistency with previous knowledge is what insured the ability of science to make reliable quantitative predictions.

The examples discussed thus far have been those in which the reported new results have, correct or not, been presented by researchers who believed in their validity. The scientific community is now being asked to scrutinize cases of fraudulent claims of scientific results.

When any new result is presented to the scientific community, the tacit presumption is that it is honest. However, this is essentially irrelevant to the question of the validity of the substantive scientific result, which will regardless be subject to the standard validation processes that make science work. It is especially important to keep quite separate the question of how and whether science is successful at maintaining its self-validation, and the question of how to recognize and deal with misconduct.

Consider the following hypothetical case. A report appears of an experiment that is claimed to yield a rather striking result. Clever investigators carry out real experiments that show that the reported result is correct, while in the meantime, incontrovertible evidence comes to light that the initial report was based on an experiment that was never conducted. The initial claim was fraudulent, although the reported "result" was ultimately found to be correct.

The procedures that test the validity of scientific information can sometimes also test for malfeasance, evidenced by the recent case at Bell Laboratories. The identical noise distributions in two spectra, presented as independent and different, is simply inconsistent in precisely the sense that we use inconsistencies to test the validity of any scientific result. Because of the very nature of noise, we can think of only one way that the two noise distributions could be essentially identical—by their actually being two representations of the same spectrum. The extreme improbability of such an event carries with it a very strong implication of deliberate misrepresentation.

I believe that scientific self-correction is functioning and is indeed maintaining the validity of the body of scientific knowledge. It may occur slowly, but it does occur. It must occur if a result is to be used in building further science. On the other hand, the issue of maintaining ethical behavior and discouraging (and punishing) its opposite in the scientific enterprise is a different issue that does not have such an obvious resolution, and needs scrutiny and careful thought.

R. Stephen Berry is the James Franck Distinguished Service Professor of Chemistry at the University of Chicago. He is also the home secretary of the National Academy of Sciences.

LETTERS

Administration Needs Sound Science

In the November 2002 "Back Page," Colin Powell states that "the formulation of our foreign policy must proceed from a solid scientific foundation." If he truly believes this, then he should try to persuade the Bush administration to listen to scientists. So far, it has not.

The Intergovernmental Panel on Climate Change, the U.S. National Academies, and the Environmental Protection Agency have all proclaimed that global climate change is a grave and pressing threat. Yet the Bush administration has actively opposed attempts to address it. The Union of Concerned Scientists and the Federation of American Scientists have argued for years that the proposed National Missile Defense will be worse than useless, yet the Bush administration continues to promote it. And international aid agencies all over the world have shown that sex education and the promotion of the rights of women are the keys to fighting AIDS and controlling overpopulation.

Yet the Bush administration has allied itself with countries like Iran, Libya, and Syria to fight against family planning programs and treaties to protect the rights of women. The citizens of the U.S., and the world, deserve more than just lip-service to scientific ideals. The Bush administration needs to base its actions on sound science, regardless of ideology.

Brian Cluggish
San Diego, California

Need to Understand How Others Think

Secretary of State Colin Powell (*APS News*, October 2002) is right in pointing out the role of scientists in the US Department of State, and the same also could be said for the ministries of foreign affairs in other countries. Let me add one point in favor. Some scientists had the occasion to work in an international surrounding as *e.g.* at CERN. They may have discovered that people from other countries on other continents, who were not educated with the logics from the ancient Greeks as one of the bases of thinking, do at times appear to behave surprisingly. Only if we really understand how the others are thinking, how they are planning, working and arguing, will we be able to discuss constructively and to transmit our thoughts and arguments to them. It is not the fact that people are speaking English which makes them think in the same way we are used to.

Reinhard Budde
Begnins, Switzerland

Letter Maligns Teller

Robert A. Levy (*APS News*, October 2002) comments on Hans Bethe's favorable review (*Physics Today*, November 2001) of Edward Teller's recent "Memoirs". Ostensibly concerned with balance, Levy quotes at length from a contrasting review of Teller's book, by Anna Mayo in "The Texas Observer".

Unfortunately Levy doesn't bother to describe the magazine "Texas Observer" or the reviewer (Miss Mayo), or to compare her qualifications as a judge of Teller and the crucial Los Alamos era with those of Hans Bethe. If a leftist critic in a leftist magazine slams Edward Teller, that's not really newsworthy. If a Fellow of the APS endorses Mayo's view, that might arguably be newsworthy. But Levy nowhere gives his own opinion. He just quotes Mayo's nasty review, replete with phrases such as "toad-like book", thereby managing to malign Teller without taking personal responsibility for doing so.

Opinions from members are fine, but judging by the results, it was a mistake to let Levy assume the role of guest editor.

James E. Felten
Greenbelt, Maryland

Junk Due to Plain Ambition

Bill Brinkman's article on scientific fraud in *APS News*, November 2002 touches on another point, often neglected in the larger discussion framed by the Schoen affair. By this I mean the practice whereby tenuous, tentative, or just plainly mundane results are pumped up by authors pursuing the attention of the larger physics community. It often goes by the name of "theory chasing," if the authors are experimentalists, or more generally "fashion passion."

This issue, namely that of over interpretation of uncertain or ordinary results, is not an occasional event, sad to say. And it speaks to the largely unspoken ethic of our profession to seek the truth, to represent our results honestly, and to accept the fact that one may, from time to time, be wrong. In the latter case let it be for the best reason: that one argued from imperfect data or just made a mistake. Usually, however, plain ambition is behind much of the junk in the literature. This not fraud but fraud's cousin, misrepresentation.

Simon C. Moss
Houston, Texas

Physical Laws Must be Obeyed

In *APS News*, November, 2002 Richard Jones *et al* provides an argument on behalf of the "intelligent design theory." I have little knowledge of this theory, so I will not attempt to address its merits. I would like, however, to point out a flaw in their argument.

Jones and company claim that, "Modern science makes the assumption that life began only by simple, natural processes," but that it is "just an assumption." Are Jones and company arguing that the laws of nature no longer apply when one discusses the origin of life? The assumption that life began by natural processes is based on the success of the existing physical theory, developed after hundreds of years of experimental study. This theory has led us to a broadly successful model of the interactions in the universe, and explains a huge variety of natural phenomena. To argue that these interactions apply in all circumstances except life is counter to a wide body of physical and biological evidence.

It may be that there is no good, well-understood theory for the origin of life. But if we are not going to discount the past several hundreds years of scientific progress, we must require such a theory to be consistent with the known physical laws of nature.

Chris Hays
Chicago, Illinois

Life's Origin Not Supernatural

I want to respond to two letters in *APS News* November 2002 issue. In "Origin of Life a Complex Question", the authors say it's unfair to put Creationists in with UFO enthusiasts. Which is more ridiculous, that aliens are visiting the Earth, or that the entire infinite Universe was somehow deliberately made by a single person?

They then say, "There is no qualitative theory, nor even a widely accepted qualitative model, for how life began from nonliving matter." Biochemists have a very good idea how it took place, and any class of biochemistry will walk you thought the process. We can almost reproduce it in the laboratory.

Even if we didn't know how it happened, we do know how it definitely did not happen. It definitely did not happen because of anything magic or supernatural. There is a logical scientific explanation for everything, even if we don't currently know what it is. The authors point out what they claim are flaws or gaps in our knowledge, and then try to subtly suggest that belief in magic should be an alternative.

See LETTERS *on page 7*

INSIDE THE BELTWAY: *A Washington Analysis*

White House Dominance May Leave Science Dangling

By Michael S. Lubell, APS Director of Public Affairs

It wasn't supposed to happen this way. The party holding the White House always loses congressional seats after its first two years in the Oval Office, political historians said.

Even on the morning of Election Day, Democratic National Committee Chairman Terry McAuliffe was so certain of victory that he repeated a prediction for NBC's Tim Russert: "Jeb Bush is gone!" A little known Democrat, he said, would sweep into the Florida statehouse. Not only that, but in the President's own home state of Texas, he prophesied, Democrats would wrest a Senate seat from Republicans.

McAuliffe was not alone in forecasting a rosy scenario for Democrats. Most pollsters predicted that the party would extend its control in the Senate, winning Republican seats in Arkansas, Colorado and New Hampshire, while holding on in Georgia, Louisiana and Minnesota. Only Missouri and South Dakota were in doubt.

But after all the ballots were counted, Republicans had made history, proving pundits, pollsters and prognosticators patently incorrect. They increased their margin in the House and regained control of the Senate. They are now in charge of the government.

It's not just the election outcome that will shape the Washington landscape, however. It's also how and why the GOP scored its triumph that matters.

These are the three factors on which the election hinged. Democrats had no message. Republicans had the cash. And President Bush had the guts to put his popularity on the line by spending most of October on the hustings. Let's examine how each is likely to affect policy in the coming year.

Democrats had no message, because for the last two years they couldn't agree on two major domestic and foreign policy questions: taxes and war. Some Democrats supported the President's $1.3 trillion tax cut. Some didn't. Some of them supported the President's plan to attack Iraq. Some didn't.

Don't look for them to find their way out of the policy wilderness anytime soon. The divisions in their caucus remain, and it will be challenging for Democrats to sing in unison. In the near term, they will have difficulty bucking the Republican tide, even though GOP congressional margins are slender.

Republicans had the cash, because corporate America saw the Bush White House as the strongest ally it's had in Washington for generations. Industry, which used to split its political giving evenly, tilted more than two to one toward Republicans in the last campaign cycle.

The election outcome will strengthen the hand of industry, produce a pro-business federal agenda and, as a corollary, accentuate the tilt in campaign giving toward the Republicans. Look for tax and trade policies favorable to business to be pushed hard at both ends of Pennsylvania Avenue.

Finally, George Bush put his political future on the line by campaigning for Republican candidates in key states. Had they lost, he would have found himself a much weakened chief executive. But virtually all of them won, and Republicans in Congress owe him big time.

In the near term, the White House will call the shots, and Congress will abide. By contrast with the last two years, when Republican appropriators rebelled against White House calls for fiscal restraint, the President's forthcoming budget will be a true blueprint for congressional action. On a host of policy issues, including defense, energy and the environment, don't look for Congress to block the President's agenda.

Where does that leave science? At best, dangling. At worst, in a deep hole.

Jack Marburger, the President's science advisor, has portrayed him as a strong supporter of science. But the record of the first two presidential budgets, which froze or cut research spending in the physical sciences, does not bode well. With the government facing a $150 or $200 billion shortfall, even absent an impending war with Iraq, the White House is likely to be very chary with dollars for research in the coming year. No doubt, it will be one that challenge's scientists resolve.

DFD MEETING, *from page 1*

lenges, ranging from the prediction of viscous damping and lubrication effects in MEMs, to the design of microengines and the understanding of bacterial propulsion.

The planet Jupiter has a 100-year climate cycle, according to Philip Marcus of the University of California, Berkeley, who predicts that within the next seven years, the day-averaged temperature of the Jovian atmosphere at the height of the visible clouds will change by 10^o circa or more. That change will be preceded by a decrease in the number of large Jovian vortices, and followed by violent instabilities along the planet's eastward-going jet streams, which in turn will lead to a repopulation of the Jovian vortices in the atmosphere.

This year's recipients of the APS Fluid Dynamics Prize and Otto Laporte Award were featured in special invited honor session. Andrea Prosperetti of Johns Hopkins University (the Laporte Award recipient) spoke about bubbles, which he described as "a tiny cloud shielding a mathematical singularity". Despite their brief lifetime, bubbles give rise to a wealth of fascinating physical phenomena: underwater noise, sonoluminescence, and boiling, among others.

The 2002 DFD meeting also featured a special U.S./Mexican mini-symposium on the dynamics and interactions of vortices. Invited speakers from both the U.S. and leading institutions in Mexico addressed a diverse range of topics, including electrically driven vortices in multipolar magnetic fields, the stability of elliptically inhomogeneous rodons, vortex pair dynamics and instabilities, Hamiltonian contour dynamics, and coupled oscillations in a vortex chain.

NUMBER EIGHT

Metallic Phase with Long-Range Orientational Order and No Translational Symmetry

D.Shechtman, I. Blech, D. Gratias, and J.W. Cahn, Phys. Rev. Lett. 53, 1951 (1984), 2155 citations

This is the third in a series of articles by James Riordon. The first article appeared in the November 2002 issue. The articles will be archived under "Special Features" on the APS News online web site.

While he was on sabbatical at the National Bureau of Standards in April 1982, Dan Shechtman made a startling discovery. He found that certain rapidly-cooled alloys of aluminum and manganese he was studying produced electron diffraction patterns just as crystals do, but the patterns showed that the alloy had an unusual rotational symmetry. In fact, the symmetry was inconsistent with the translational symmetry that effectively defined a crystal. Shechtman had inadvertently stumbled across a quasicrystal.

In normal crystals, atoms lie on three-dimensional lattices of cells. Each cell has an identical pattern of cells surrounding it. In a quasicrystal, the local arrangements of atoms are fixed, but each cell has a different configuration of cells nearby. Although the structures are strikingly similar to the quasiperiodic tilings invented by mathematician Roger Penrose (which Martin Gardner popularized in a 1977 Mathematical Games column in Scientific American), there was little in the crystallographic field to presage the experimental breakthrough. Shechtman himself did not immediately recognize the quasiperiodic structure in his sample, and was at first mystified by the diffraction pattern. "I knew the diffraction pattern was not from twins [which result from a common crystal defect]," recalls Shechtman from his office at Technion University in Israel, "but I did not come up with an explanation for what it was."

Quasicrystals would eventually inspire a tidal wave of activity in crystallography, mathematics, physics, chemistry, and material science. Initially, however, Shechtman's discovery was viewed with skepticism. "For two years I did not have anybody who believed my results and was usually ridiculed," says Shechtman. "The scandal of polywater was still in the air, and I feared for my scientific and academic career."

Fortunately, one of his colleagues at Technion University was willing to take Shechtman's data at face value. "In 1984," says Shechtman, "Ilan Blech proposed the model, later known as the Icosahedral Glass model." Together, the researchers wrote up an article that contained the model and the experimental results, and sent it off to the *Journal of Applied Physics* in the summer of 1984. "*JAP* rejected it on the grounds that it would not reach the proper readers and suggested I send it to a metallurgical journal." Shechtman and Blech took the *AJP* editors' suggestion. The article was accepted by *Metallurgical Transactions*, but remained unpublished for nearly a year.

Eventually, Shechtman brought the article to the attention of John Cahn, his longtime host at National Bureau of Standards (now the National Institute of Standards and Technology) and an eminent materials scientist. Cahn recommended streamlining the paper; leaving out details of the model and experiment, and limiting it solely the experimental findings. After consulting with Denis Gratias, a mathematical crystallographer at the Centre National de la Recherche Scientifique in France, the group submitted an abbreviated article to *Physical Review Letters* in October 1984, more than two years after Shechtman's initial experiment. The article was published several weeks later.

This time the response to the paper was almost immediate, says Shechtman. "Scientists from around the world called me days after the *PRL* publication to say, 'We did it and we see what you saw.'" Discussion of Shechtman's paper dominated an international conference on mathematical crystallography held a few months after the letter's publication, and by 1986 the first international meetings dedicated to quasicrystals were under way. "The discovery brought a fresh breeze to young scientists looking for a challenge," says Shechtman, "and quasicrystal science is a challenge, big time."

The fact that so many researchers could duplicate Shechtman's work so rapidly presents something of a puzzle. How could quasi-crystals have evaded the community of crystallographers for so long? "That is a question I have tried to answer many times," he replies. In addition to the vital input he received from his collaborators, says Shechtman, his discovery required several critical components. First, it was necessary to make esoteric, rather than useful, rapidly-cooled alloys. Then a researcher would have to study them with a transmission electron microscope ("And be damn good at it", he adds), perform numerous detailed analyses, and finally "Face the world of nonbelievers, face ridicule, and defend your idea? Shechtman concedes that it's likely others may have previously seen quasicrystals without realizing it. "Seeing it was just one step in the long process that led to the article in *PRL*."

Blech left Technion to pursue microelectronics production in Silicon Valley shortly after helping Shechtman identify his quasicrystal sample. Cohn is now an emeritus researcher with the National Institute of Standards and Technology, and was a 1998 recipient of the National Medal of Science for his contributions to materials science, solid-state physics, chemistry and mathematics. And Gratias is currently director of the Laboratoire d'Etudes des Microstructures in France.

Shechtman is still at Technion and, except for a five year interlude dedicated to chemical vapor deposition of diamond, has spent nearly all his career studying quasicrystals. The discovery that he once thought might be an embarrassment tantamount to the polywater scandal has had a dramatic effect on his life. "It exposed me to several sciences, made me known to very many, and put me in the focus of meetings and discussions," says Shechtman. "In the four years that followed the *PRL* paper, I gave one hundred lectures worldwide." He has received numerous prizes and awards for his quasicrystal research, and is nominated for many more.

Oddly enough, Shechtman has one complaint about the field that he originated: use of the word quasicrystal. "I do not like the term, since it implies that quasi-periodic crystals are not crystals, and according to the new International Union of Crystallographers definition, they are. But the term is widely used. I prefer to call them quasi-periodic materials. The term quasicrystal, in fact, does not appear in the article ranked eighth on our list of the ten most-cited *Physical Review Letters*.

White Papers Highlight Opportunities For Counter-Terrorism Research

By Bob Guenther

Earlier this year, APS President Bill Brinkman created a Task Force on Countering Terrorism and asked me to be its Chair. Other members are: Mark Coffey (TRW); Harold Craighead (Cornell); Leonard C. Feldman (Vanderbilt); Gerard P. Gilfoyle (University of Richmond); Martin V. Goldman (Colorado); Beverly K. Hartline (Argonne); Al Romig (Sandia); and Paul Wolf (Air Force Institute of Technology). [See *APS News*, April 2002 and November 2002].

The objective of the Task Force has been to survey the current activities in the area of counter-terrorism, identify technical issues where physics might play a role and to make the physics community aware of these issues.

The most important mission of the task force is to stimulate the physics community to contribute to homeland security by devoting a small portion of the community's research activity to the solution of these highlighted technical issues.

The Task Force reviewed the counter-terrorism efforts that were underway at government agencies and at some professional societies, and after further discussion narrowed possible technology issues to areas where physics would make the greatest contribution: Sensors; Materials; and Data Systems.

Task Force members have prepared brief white papers on technologies that fall within these broad topical areas. In furtherance of the mission of the Task Force, these white papers are summarized at right, and are available in full online at www.aps.org/apsnews/whitepapers. It is our hope that APS members will seriously consider ways in which they might contribute to the research areas that are outlined in these articles.

Another way for physicists to learn about counter-terrorism is to attend a special workshop that will be held on Sunday, March 2, just before the APS March meeting in Austin, Texas. Titled "*The Role of Physicists in Countering Bioterrorism*", the workshop will review the bioterrorism threat, describe current biological detection techniques, and explore the role of spectroscopic techniques in species detection and recognition.

Bob Guenther is Professor of Physics at Duke University.

Swarm Intelligence, by Gerard P. Gilfoyle

A group of non-intelligent agents — robots, sensors, etc. — can interact with their environment and each other to produce collectively intelligent behavior, similar to an ant colony. E.g., telecommunications firms are using computational "ants" (agents) to produce faster, more robust communications networks. Transportation firms use these algorithms to pick the best way to rout gasoline trucks.

Protection and Decontamination of Surfaces, by L.C. Feldman

Innovative surface science plays a cross-cutting role in sensing, protection and decontamination, all areas of critical importance to counter-terror efforts. While much progress is being made in detecting and identifying toxic agents, in general, there is a lack of materials and methods for the large-scale remediation of bioterrorism pathogens, or for the clean-up of disinfecting agents.

Single Molecule Sensors, by Harold Craighead

The ultimate in sensitivity is required for the timely detection of chemical, biological and explosive toxic agents at the lowest possible concentrations, which could be achieved with single molecule sensors.

Bio-Inspired Sensors, by Paul Wolf

Nature has produced extraordinary sensor systems in biological species that exceed the capabilities of most man-made sensors. Understanding the processes responsible for these sensory abilities may produce a blueprint for replicating them in man-made devices.

Chemical and Explosives Detection, by Mark Coffey

While there are several methods currently available for the detection of chemical weapons and explosives, the development of new methods would be very useful, particularly nuclear quadrupole resonance, which has potential as a bulk detection method.

Non-Destructive Evaluation Technologies for Container and Vehicle Inspection, by A.D. Romig

NDE is a relatively mature field of technology that is of particular interest as a tool for homeland security. But fast, reliable, nondestructive inspection of cargo, vehicles, and personal baggage is a formidable technological and operational challenge.

Addressing Nuclear and Radiological Terrorist Threats, by Martin Goldman

Two major terrorist threats are the detonation of nuclear weapons or devices, and the release of radioactive materials through the use of "dirty" bombs. The physics community can help improve detection of illicit weapons and nuclear materials, and help educate the public about radiation processes and the limited risks associated with radiological devices to ward off panic.

Bio-Surveillance Systems, by Beverly K. Hartline and Darrell Chandler

In the area of biosurveillance, no one technology satisfies the disparate operation needs of modern society. An idealized system that would satisfy many of these needs is the fictional "Tricorder" popularized in the "Star Trek" series, which could offer a useful model on which to build future technologies.

Focus on Committees

Committee Helps Keep Meetings Healthy


David Tanner

The annual March and April Meetings of the APS are important to the physics community and one of the most important services provided to APS members. To assure that the meetings are as productive and enjoyable as possible for members, the Society has a Committee on Meetings. It consists of eight individuals —six APS members and two APS officers—and serves to monitor the status of the meetings and provide guidance to the APS staff on issues relating to the general meetings.

“The committee acts as advisor to the Meetings Department, which handles all of the logistics for the meetings, and works with the program committees to plan the programs,” said Donna Baudrau, the Staff Advisor to the Committee and director of the Meetings Department.

The committee's function, she says, is to review the health and efficacy of the meetings, including finances, attendance levels and demographics, and provide advice on matters such as registration fees, audiovisual policy, abstract submission, existing programs and new program proposals. The committee also reviews the status of ancillary programs at the meetings, such as the Student Lunch with Experts, and the child care service provided at the March Meeting.

“The committee considers aspects of the meetings related to the mechanics and process of how the meeting runs, but not issues like content or location,” said committee chair David Tanner, a physics professor from the University of Florida at Gainesville. “We cover most of the meetings that APS runs, but really focus on the March and April Meetings.”

Review of registration fees is undertaken by the committee every year or two. At this year's meeting, the committee weighed the propriety of a registration fee increase for the March Meeting to cover additional costs. After consulting with APS treasurer Thomas McIlrath, the committee approved an increase of $25 for members, $50 for nonmembers, and $10 for students and retirees. The increase will offset the cost of expanding the audio-visual package that will include LCD projectors in every room for the first time. These will be in addition to the overhead projectors that have been traditionally provided.

Another concern for the committee right now is the 2004 March Meeting, which will take place in Montreal. The committee is concerned that physicists in the United States on visas, and physicists from other countries who will need visas to enter Canada, may have difficulty in arranging for travel to and from the meeting, because of the tightened security measures now in place and new restrictions governing travel.

“Physics is such an international discipline that we have to be concerned with how this will affect foreign students and postdocs who are studying and working in this country,” said Tanner. “The committee is being responsible by thinking about this early, especially by considering the foreign citizens in the U.S. It could be a nasty situation if it is not handled right.”

While it is too early to take specific action yet, the committee members said they will follow travel guidelines closely and, with the help of APS director of international affairs Irving Lerch, issue recommendations in the months before the meeting. At its most recent meeting, the committee emphasized that all members of the physics community should keep abreast of international travel laws, as they are changing rapidly and could affect some physicists' ability to travel to the meeting.

Committee member Kate Kirby says the committee does an important job. “Meetings are an extremely important aspect of service to the APS membership,” Kirby said. “It is critical that the Meetings Department of APS carry out planning and discuss policy issues with a committee of APS members.”

—Desirée Scorcia

APS Council Approves Study on Humanitarian De-Mining

At its November meeting, the APS Council approved the initiation of a study on humanitarian de-mining, pending the acquisition of sufficient external funds to cover the cost of such a study. An official charge will be developed and members appointed once funding has been obtained. The proposal arose from the APS Panel on Public Affairs (POPA), and calls for an extended study of over 18 months, with a panel of 15 physicists and engineers and a full-time study director. The intended audience includes private foundations, members of Congress and their staff, international agencies, the U.S. Departments of Defense and State.

“We expect the report will help funding agencies, especially those having little technical capability, to better decide upon which technologies to support for research, design and development,” says Andrew Sessler (University of California, Berkeley), who co-wrote the proposal with Surajit Sen of SUNY-Buffalo. “We also expect that the study will stimulate the involvement of the community of physicists in the development of and evaluation of new technologies that are yet to be incorporated into existing programs.”

According to Sessler, the U.S. General Accounting Office (GAO) estimates that approximately 127 million landmines in 55 countries cause some 20,000 casualties each year. While there is an obvious need to detect, disarm, and remove the landmines, the current pace is very limited and existing programs require risky, manpower-intensive techniques that cost as much as $1,000 to remove a $3 mine. Current global budgets for manual detection and removal of mines are only about $200 million per year, which means it would require hundreds of years to solve the problem with money alone.

New and more reliable technologies, and significant improvements to existing technologies, are needed to will allow faster, cheaper de-mining. The GAO has identified 19 technologies that have been considered for de-mining, 17 of which are physics based. The scientific and technical dimensions of the problem are immense, including electromagnetic signatures, infrared, millimeter waves, conductivity and resistivity, quadrupole resonance, X-ray fluorescence, acoustic sensing, and neutron activation.

Part of the study's focus will be to help identify the most promising new technologies for humanitarian de-mining. This will require a fairly detailed technical assessment of various technologies, and hence the study panel will include not just physicists familiar with basic sensors, but also engineers with experience in developing new technologies for field use. The study will review the contributions of the DOD and the engineering communities, and then focus upon the area of long-term R&D beyond the horizon of private companies.

A Back Page on de-mining appeared in the July 2002 issue of *APS News*. It was written by Richard Craig of Pacific Northwest National Laboratory, and is available online at http://www.aps.org/apsnews/0702/070209.html .

DPP MEETING *from page 1*

occasionally observed in space, enabling researchers to improve their understanding of real astrophysical jets.

Lab-Based Recreations of Extreme Astrophysical Phenomena. Using a new technique, researchers from Imperial College, London, and the Rutherford Appleton lab in the UK have created super-strong magnetic fields that are hundreds of times more intense than any previous magnetic field created in an Earth laboratory and up to a billion times stronger than our planet's natural magnetic field. Such intense magnetic fields may soon enable researchers to recreate, extreme astrophysical conditions, such as the atmospheres of neutron stars and white dwarfs (in their very own laboratories.)

At the Appleton Lab, researchers at the VULCAN facility aimed intense laser pulses, lasting only picoseconds, at a dense plasma. The resulting magnetic fields in the plasma were on the order of 400 Megagauss. Due to technological advances, peak laser intensities are likely to increase still further and consequently even higher magnetic fields may soon be possible, making it possible to put models of extreme astrophysical conditions to the test by using X-rays to generate nuclear fusion.

Working toward the vision of generating clean energy from nuclear fusion, researchers have successfully imploded fuel capsules by bombarding them with intense x-rays. The results show that the process generates significant fusion and that the implosion method looks capable of generating large-scale energy production.

In one set of experiments, a high degree of symmetry has been achieved in the implosion process. In another set of experiments, researchers observed significant production of neutrons, a sign of nuclear fusion. These successful experiments are an important step toward ignition, the level at which the fusion reaction becomes self-sustaining and excess energy can be drawn from the process for other applications.

First 3D Magnetic Reconnection Measurements. In work that promises new insights into the cosmos and fusion-energy production alike, physicists have reported they have made the first 3D laboratory measurements of magnetic recon-nection, the main process by which magnetic fields release energy in the universe. This process is thought to heat the solar corona, as well as to accelerate particles to high energies, possibly even to the very high energies of cosmic rays. Magnetic reconnection is also an important process in some experimental fusion energy reactors that use magnetic fields to confine the plasma.

Until recently, this process has been studied only in two dimensions. Now, 3D experimental measurements of magnetic reconnection have been made at the Swarthmore Spheromak Experiment (SSX) at Swarthmore College. At SSX, physicists merge rings of magnetized plasma called spheromaks. Measurements reveal a swept and sheared magnetic structure in the reconnection region. Researchers hope to elucidate fundamental plasma physics processes on the sun and understand new plasma structures in magnetic confinement fusion machines.

Hollow Plasma Doughnut Currents. Doughnuts of plasma can be coaxed into configurations with hollow current rings, providing practical advantages over conventional “filled doughnut” shapes. Simulations suggest they will allow faster turn-on and greater efficiency of future nuclear fusion power plants. Plasma doughnuts normally carry large electric currents throughout their volume but researchers expected the direction of the current could be changed back and forth.

However, in recent experiments at the Joint European Torus (JET) and JT-60U tokamaks in England and Japan, researchers tried to reverse the current and found that the current doughnut became hollow. Now computer simulations conducted by researchers at the DOE's Princeton Plasma Physics Laboratory (PPPL) using supercomputers at the National Energy Research Supercomputer Center have explained this phenomenon. Instead of the electric current reversing direction, the plasma experiences magnetic reconnection and the core becomes stabilized with zero current. As soon as a current tries to reverse in the center, it is pulled into the outer ring. This new understanding should allow a more practical design of compact next-generation fusion experiments.

Turbulence Restrains Itself. Magnetically confined plasmas in tokamaks and related fusion devices exhibit a high degree of turbulence, which can generally destroy the optimal conditions for producing fusion energy. Now, scientists have experimentally confirmed that turbulence can actually limit its own ability to wreak havoc. Researchers at the DIII-D tokamak at General Atomics have discovered that turbulence generates its own flows that act as a self-regulating mechanism. These flows create a “shearing” action that destroys turbulent eddies.

These turbulent flows have been clearly observed in recent experiments at DIII-D by using a special imaging system, which is helping to advance researchers' understanding of this complex and crucial phenomena taking place in high temperature fusion plasmas.

The roiling turbulence inside tokamaks represents some of the most complex physics on the planet. Using the full power of the world's largest supercomputers, scientists have now been able to fully simulate the movement of tokamak particles and heat due to turbulence. Implementing new algorithms to incorporate very complex physics, they included the effects of super-fast electrons and the recent practice of rotating the plasma, for higher-pressure tokamak operation and higher-energy output. These simulations may also help greatly in making reliable predictions for larger tokamaks and future commercial-scale fusion reactors.

ANNOUNCEMENTS

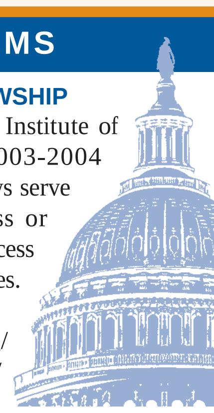
APS Mass Media Fellowship Program

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

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/

Now Appearing in RMP Recently Posted Reviews and Colloquia

You will find the following in the online edition of Reviews of Modern Physics at http://rmp.aps.org.

The evolution and explosion of massive stars

—S.E. Woosley, A. Heger, and T.A. Weaver

We are made, aphoristically, of star dust, the debris from supernova explosions. The processes leading up to these explosions are the subject of this review of massive star evolution. While the nuclear reactions are fairly well understood, the post-collapse dynamics are still problematic with questions on the effects of convection, rotation, and magnetic fields.

Helioseismology

—Jorgen Christensen-Dalsgaard.

Photons tell us about the sun's surface and neutrinos about the inner core, but the only probe of the bulk in between is helioseismology. As described in the article, solar oscillation frequencies can be measured with high precision; they are sensitive to the internal distributions of sound, speed, and density, and hence temperature and composition, as well as rotation and other flows in the solar interior.

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.

Physical Review Focus

http://focus.aps.org

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.

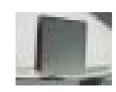
Some November and December *Focus* Stories:

Underwater Desert

A new technique generates miniature dunes in a water tank and appears to verify fundamental principles of dune formation.

New Nano Capacity

A quantum mechanical effect seems to explain amplification in a component that might replace transistors in nanoscale circuits.



Light Given New Direction

A slab of a new kind of material can focus diverging electromagnetic waves into a narrow cone.

Detecting Dark Dimensions

Dark matter arising from extra spatial dimensions could be detected with existing or future experiments.

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

Visit *APS News* Online

http://www.aps.org/apsnews/

CONDUCT, *from page 1*

conferences, or provide scientific leadership for junior colleagues."

"Coauthors who make specific, limited contributions to a paper are responsible for them but may have only limited responsibility for other results," the guidelines state. Furthermore, "any individual unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor."

To assist coauthors in fulfilling their responsibilities, the APS Council resolved that, "Collaborations are expected to have a process to archive and verify the research record; to facilitate internal communication and allow authors to be fully aware of the entire work; and respond to questions concerning the joint work and enable other responsible scientists to share the data. All members of a collaboration should be familiar with, and understand, the process."

"These actions are our initial response to the recent findings of major research misconduct," said James Tsang, chair of the APS Panel on Public Affairs. "Those findings challenged many cherished assumptions and beliefs. We have reaffirmed our community's commitment to high professional standards and that such standards are essential to both good science and public confidence. We have extended previous guidelines in describing our expectations for professional conduct by physicists. Together with the recent unfortunate events, our actions make clear the professional consequences of research misconduct."

The APS Council believes that research misconduct is extremely damaging as it "diminishes the vital trust that scientists have in each other", "undermines public confidence in science" and "can lead significant numbers of scientists along fruitless paths" according to its new Statement on Policies for Handling Allegations of Research Misconduct. The Statement continues, "It is imperative, therefore, that the institutions responsible for the funding and performance of scientific research, as well as the relevant professional societies, take appropriate steps to discourage such conduct and have policies and procedures in place to deal with allegations of misconduct."

As concrete recommendations, the APS Council urges that all federal agencies complete their required implementations of misconduct policy and that all research institutions, regardless of funding, develop and implement plans consistent with the Federal Policy on Research Misconduct.

Some of the procedures the APS plans to implement are outlined in the newly adopted Statement on Improving Education for Professional Ethics, Standards and Practices. The APS calls on its members and units to actively promote education in this area, in line with its belief that "it is part of the responsibility of all scientists to ensure that all their students receive training" specifically in professional ethics and standards. The APS Council sees this as an ongoing project and is establishing a task force to monitor progress and consider new steps regarding ethics, standards and practices for the society. Serving on the task force will be Frances Houle, E. W. "Rocky" Kolb, Kate Kirby, and Joe Hamilton.

PHILADELPHIA, *from page 1*

scientific amusements.

Speakers at the three plenary sessions will cover a broad range of topics, including the mysteries of extra dimensions, antimatter, quantum chaos, and the study of matter, space and time at the energy frontier. There will also be several talks on topics in astrophysics, such as the current status of gamma-ray bursts, solar neutrinos, and observations (by the Chandra Observatory) of supernova remnants and young neutron stars.

The latter two topics will also be addressed on Saturday, April 5, during a special invited session featuring Riccardo Giacconi of Associated Researchers Inc. and Masatoshi Koshiba of the International Center for Elementary Particle Physics in Tokyo, Japan, co-recipients of the 2002 Nobel Prize in Physics, along with Raymond Davis, Jr. of the Brookhaven National Laboratory (See *APS News*, December 2002),

The two men will discuss the research for which they were honored by the Swedish Academy.

SARACHIK, *from page 3*

for me to do. I would urge all physicists in all subfields and in all sectors to join the Society because the APS represents us all. The physics community needs to stay in touch with us and I urge APS members to inform us of their concerns and needs, and to play an active role in the Society's affairs. I was given a special opportunity to serve the APS when I was asked to run for president. And I'm delighted have the opportunity to do so.

LETTERS, *from page 4*

In another letter Mike Kent says, "Intelligent design and naturalism are both possible inferences that one might make from the data and knowledge of science." There is absolutely no evidence that there has been artificial selection in the evolution of life on this planet, other than that done by humans. When he says "intelligent design", he is referring to the Judeo-Christian God. This is another example of someone pretending that belief in magic constitutes a scientific theory. They don't want to come out and say it, because they know how ridiculous that sounds, but that's the implication.

Jeffery Winkler
Hanford, California

Authorship Should be Limited

I read W. Brinkman's "Scientific Fraud—Lessons Learned" (*APS News* November 2002 issue) with interest. I think he is moving in the right direction, but one issue that deserved more attention was multiple "authorship" on papers reporting results of big physics projects. Some of the reports have listed several hundred participants as "authors". This doesn't add up: 300 authors on a 3,000-word paper equals 10 words per author. Should contributing 10 words mean coauthorship of a 3,000 word paper?

I think not. This is just an honorific form of authorship which shifts responsibility away from the person(s) actually writing the report. Many of these "authors" will have contributed calculations, "crystals" (as mentioned by Brinkman), unique insights, criticism, *etc.*—but none of these justify mention as other than a technical assistant, consultant, or peer reviewer.

There are two distinct efforts in such projects: Completion of the work, and authorship of the paper. Participants should be encouraged to write their own papers, in addition to the "main" report bearing everyone's name. The actual authors should be revealed, so they might be contacted by readers for meaningful comment, criticism, or questions.

I would suggest that the team leader, or a designated author, write such a report. The many other participants possibly should be listed NOT as authors, but as other valued team members. Perhaps all the names should be listed on the first page, as often done—but not as "authors"; rather, perhaps, as "project contributors", "scientific coworkers", or something along these lines. Socialistic honorifics are just as bad as royal honorifics, as I see it.

John Michael Williams
Redwood City, California

THE BACK PAGE

Science, Uncertainty and Risk: The Problem of Complex Phenomena

By Richard L. Wagner, Jr.

Science is increasingly involved in making statements about physical phenomena that influence, and are influenced by, human activities. The discourse among scientists, policy-makers and the public about such phenomena is likely to become increasingly important and increasingly difficult. Climate change is a famous example. There are many more such cases today, and there will be many more in the future.

This particular discourse is about risk, and about how polities assess and manage risk through processes which are difficult and imperfect. How scientists assess and portray uncertainty in what we say about complex physical phenomena is also difficult and imperfect. To improve communication, the public and decision-makers must come to understand science better. For our part, scientists must work on our side of the gap by learning how to better assess and describe the basis for confidence in what we say, particularly about uncertainties.

The touchstone for confidence in science's statements about physical phenomena is experiment. Richard Feynman once said, "The test of all knowledge is experiment. Experiment is the sole judge of scientific 'truth'." But increasingly, for many phenomena at the intersection of science, public understanding, and policy decisions, it is impossible to do the definitive experiment(s). One could hardly validate climate models by inducing a deliberate change in climate. Indeed, the more complex the phenomenon, the more important and more difficult it is to design sufficient experimental validation. Controlled experiments can often be done for disaggregated pieces of a complex, integral phenomenon, but without designed integral experiment, how the errors and uncertainties aggregate will remain in doubt, further complicating risk assessment and management.

This is both an epistemological problem of some depth and a practical one in terms of how science is applied, and developing approaches to it might be termed applied epistemology. Making progress will require sustained effort aimed expressly at this problem. Useful approaches are likely to focus on how those experiments that can be done relate to confidence or doubt about understanding and prediction of the overall, integrated phenomenon.

There are, of course, well-established fields of study in which observations and measurements can be made, but controlled, designed experiments on the entire phenomenon cannot be done, as is the case with many questions in astrophysics. Another set of complex physical phenomena is involved in the question of reliability of nuclear weapons in the absence of nuclear testing. How to assess and describe the uncertainties in the physics and engineering involved, and how to establish the basis of confidence in statements about those uncertainties, are questions that are getting increased attention at the Los Alamos and Livermore laboratories, as well as from scientists outside those facilities. There could be a mutually beneficial interaction between scientists thinking about how to assess confidence in statements about other complex physical phenomena and those who are thinking about this problem in terms of the weapons application.

Whether or not the nuclear weapons case proves illuminating, more attention should be focused expressly on developing better ways by which confidence and doubt, certainty and uncertainty, about complex physical phenomena can be assessed and conveyed, especially where definitive, designed and controlled experiments cannot be done. This should be a project for science in the coming decades.

> *"…we should look again at the fundamental: at our basis for confidence in assessing uncertainty."*

I previously referred to climate change. As human activity increasingly impinges on the ecosphere, as it will, virtually every aspect of the physical and biological functioning of the ecosphere, including ourselves, is likely to become the subject of risk assessment and management. One hundred years ago, the ecosphere was essentially sovereign in its functioning. Now, we are trying to limit the impact of human activity on it. Despite our current efforts, 50 or 100 years from now, human activity may be sovereign, and a properly functioning ecosphere may be one that is engineered. (For many reasons, I personally find this worse than painful to contemplate. But it may be a reality we should prepare for, although doing so might make it a self-fulfilling prophecy.) If humankind must engineer the future ecosphere, it will be an imperative of truly historical proportions for science to be able to accurately assess uncertainty and convey the basis for confidence in those assessments.

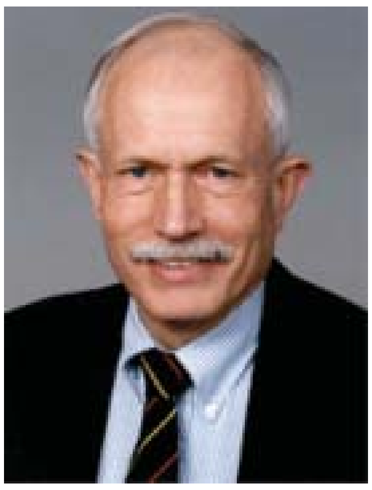
Of course, scientists usually work very hard to assess the uncertainties in their predictions. The climate community is a fine example. Despite this, such assessments often turn out to have been wrong, and as the stakes of being wrong increase, as they will, perhaps we should look again at the fundamentals: at our basis for confidence in assessing uncertainty. Scientists deal with complex phenomena in many ways. The following conceptualization will, I believe, serve to illustrate the underlying problem of understanding and describing the connectedness of less-than-definitive experiment to assessments of uncertainty.

Sciences approach many complex phenomena by building models, often large computational models. The structure of such models is often to disaggregate the overall integral phenomenon in question into less complex components, continuing this process until, at the finest level of detail, the individual phenomena—what scientists consider fundamental—are isolated and can be dealt with by well-established theory, the result of all the previous efforts in science.

This is the classic reductionist approach of science. But for the complex phenomena at issue here, the models must reaggregate the phenomena, and each of them, even those considered fundamental, have uncertainties associated with them. These uncertainties may be as simple and fundamental as experimental uncertainty in measuring the values of physical constants, but often they are much more complicated. As the model integrates them, the uncertainties concatenate in complex, nonlinear ways. In developing the model's strategies for disaggregation and reintegration, judgments are made—often on the basis of physical intuition—about how these nonlinearities work, and how much computational and experimental effort should be applied to each of the disaggregated phenomena.

These problems are not so bad when designed, controlled experiments can be done to measure many aspects of the phenomenon to validate the models. But when such experiments cannot be done, estimating uncertainty becomes very difficult. Often, designed experiments can be done at intermediate levels of aggregation, and measurements can almost always be made on aspects of the overall phenomenon. But insidious fudge factors can creep in, especially when the models being validated are used to interpret the measurements. An even more fundamental problem is captured in the old saw, "Nobody believes a calculation except the person who did it, and everybody believes an experiment except the person who did it."

Complexity theory offers a different conceptualization of how scientists deal with complex nonlinear phenomena. It deals head-on with the problems of reintegration of disaggregated phenomena by treating features of the overall phenomenon as emergent behavior. But the problem still remains of assessing uncertainty, and the basis for confidence in that assessment, especially absent definitive experiment. Using small-scale experiments raises problems of scaling and specification of boundary conditions.



Richard L. Wagner, Jr.

Since the last U.S. nuclear test a decade ago, Los Alamos and Livermore have carried out a large program to strengthen the scientific underpinnings of the phenomena that occur during nuclear explosions. Supporting this work are large facilities for non-nuclear experiments, with more on the way, and computational power already in the tens of teraflops. Funding applied to this work has been several billion dollars. It may be the world's largest, single current program in applied science focused on a particular set of complex phenomena.

In that program, the problem of assessing uncertainty, and the basis for confidence in those assessments, without the ability to do definitive experiments (*i.e.*, nuclear tests), has much in common with the other kinds of complex phenomena I have described. But it differs in one useful way: nuclear tests were done, with extensive measurements of the phenomena involved, many times before the last U.S. nuclear test. And it may be useful in a more particular sense. A pivotal issue is whether the data from those nuclear test measurements are sufficient to validate the models with enough rigor to allow confident statements about the performance of weapons in configurations that are to some degree different—because of aging or remanufacture—from the configurations tested.

Within this program, structured approaches to assessing uncertainty are just beginning to emerge, and currently come under the heading, "Quantifications of Margins and Uncertainties" (QMU). The "margins" are between acceptable values for the performance and reliability parameters of various phenomena, and the predicted values. Defining those margins and how the various performance parameters relate to each other is not easy. Neither is quantifying uncertainties. We would like to be able to base statements about uncertainties directly on measurement, perhaps even on measurement error, but the relationship between some of the performance parameters and what has been and can be measured is unclear. This is in part because of the difficulty in scaling across wide ranges of size and energy density. The hardest part is structuring and interrelating the uncertainties, including those that can't be quantified. Thus far there has been little explicit attention to metrics and frameworks for these relationships between experiment and confidence or uncertainty. The whole program is a work in progress, and there is no guarantee of success.

I do not see a clear way forward for addressing the problem I have posed and illustrated in this article. Perhaps it will not be solved, only improved. Bringing the emerging theories of complexity to bear on how models reaggregate phenomena might be one avenue of approach. Developing strategies for model development that allow models to be more amenable to experiments that check how the disaggregations are reintegrated might be another.

Still another might be developing structured methods by which uncertainties in the integrated phenomena are tied as directly as possible to those experiments that can be done. Ultimately, how much credence to place in the predictions of various models is based in the judgment of those who understand them, their relation to experiment, and the experiments themselves. If that judgment can be parsed out, and reduced as much as possible to judgments about the possibilities of systematic error in experiment, some progress will have been made.

It is not too sweeping to say that the scientific method cannot be fully applied in the cases of complex phenomena for which designed, controlled experiments cannot be done. And there are profound implications, for science and its applications, in the inability to use the scientific method in these matters.

The claims of science to "truth" are under attack in certain quarters. I think most scientists believe these attacks are either without basis or are based on a misunderstanding of scientific claims. But as the stakes rise, these attacks are likely to intensify, and they will hinder the ability of science to contribute. Developing, during the next decades, something like an extension of the scientific method that deals with confidence and uncertainty when definitive experiments cannot be done is a crucially important task for the scientific community to attempt.

Richard L. Wagner, Jr., is a senior staff member at Los Alamos National Laboratory.