APS NEWS

JUNE 1998 THE AMERICAN PHYSICAL SOCIETY VOLUME 7, NO 6

Try the enhanced APS News-online: [http://www.aps.org/apsnews]

9
Months to Go

Quantum Computing, MEMs, Spintronics Mark 1998 L.A. March Meeting

More than 5000 physicists converged on the Los Angeles Convention Center in Los Angeles, California, 16-20 March, for the Society's annual March Meeting. Approximately 4500 technical papers were presented, mostly on topics in condensed matter and materials physics, as well as related fields, making it one of the largest physics meetings ever. APS subunits represented at the meeting included biological physics, chemical physics, condensed matter physics, fluid dynamics, high polymer physics, and materials physics.

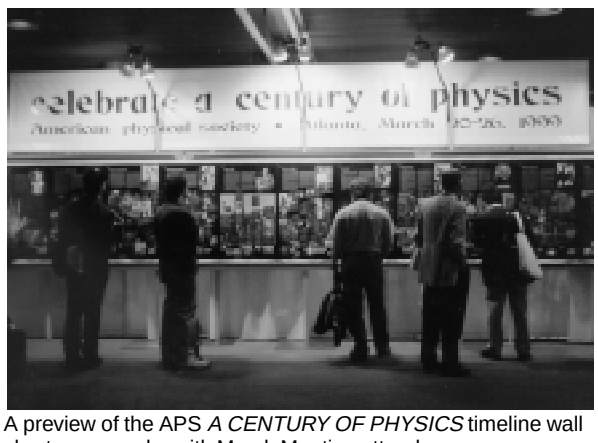
Among the technical highlights were papers on quantum computing (see page 4), an emerging applied physics field based on spin-dependent phenomena, dubbed "spintronics" (see page 4), and microelectomechanical systems (MEMs) (see page 5). Nontechnical highlights included a special lecture by Ernest Moniz, Under Secretary of the Department of Energy (DOE), providing an overview of the current national funding priorities and impact on DOE research programs (see page 4), as well as talks on physics, stockpile stewardship, new technologies for energy conservation, and preparing physics graduate students for careers outside the academic Ivory Tower.

The traditional ceremonial session for the bestowal of prizes and awards was held Monday evening, followed by a reception hosted by APS President Andrew Sessler (Lawrence Berkeley Laboratory). Eleven APS prizes and awards were presented, and the winners gave lectures on their respective award-winning topics at various sessions throughout the week. Citations and brief biographical summaries of the recipients appeared in the March 1998 issue of *APS News*.

Vortex Crystals. Many fluids in nature move principally in two dimensions; one example is the Great Red Spot of Jupiter, the hurricane-like tempest on the giant planet. The mathematical equations describing ideal, frictionless versions of these two-dimensional fluids are identical to those governing the movement of charged particles trapped in a strong magnetic field. Exploiting this connection, Fred Driscoll and his colleagues at the University of California, San Diego have recently built an apparatus that for the first time allows a full spatial imaging of the flow of electrons trapped in a magnetic field. The density of electric charge

(continued on page 3)

Fran Atkinson of the APS Membership Department stood ready to help members at the March Meeting in Los Angeles.



A preview of the APS *A CENTURY OF PHYSICS* timeline wall chart was popular with March Meeting attendees.

Inside...

APS Career and Professional Development Liaison Program Launched

The APS Committee on Careers and Professional Development (see page 8) sponsored the first workshop to kickoff a Career and Professional Development Liaison (CPDL) Program on March 15, 1998 at the APS meeting in Los Angeles. Over 50 participants attended the inaugural workshop, including representatives from 35 academic physics departments plus several industries and government laboratories. The purpose of the workshop was to initiate the CPD Liaison Program and to initiate a dialog with a small group of interested departments on how such an APS program could be most useful. Diandra Leslie-Pelecky, University of Nebraska, and Barrett Ripin, Associate Executive Officer of the APS organized the Workshop.

A motivation behind the establishment of the CPDL program is to assist faculty members by providing good career/employment information, a resource of 'good practices' that have proven useful in other departments, suggestions on how to set up student internships and foster closer ties with physics related industry, and develop other ways that physics departments could help prepare students for a diversity of career options. "Despite our good intentions, we sometimes can't provide all of the information our students need," complained one department chair attending the workshop. The CPDL model varies greatly. It can range from a faculty member who makes career activities his or her passion after retirement, an active faculty member, or, in some cases, a student-driven initiative. Regardless of which model is followed, there are two essential elements - continuity and commitment.

Experts in physics career issues presented statistical information and featured innovative programs designed to assist students and faculty in planning and executing job searches at the Workshop. Barrett Ripin started the Workshop by describing the motivation and purpose of the CPD Liaison Program as recommended by the APS Task Force on Careers and Professional Development and the newly established APS Committee on Careers and Professional Development. Roman Czujko of AIP provided the current statistics on employment among physics graduates and was followed by Sherrie Preische of APS, who summarized the findings of a recent e-mail survey of APS junior members regarding their hopes and experiences with the job market (see February 1998 *APS News*).

A panel discussion about models for internship programs featured Peter Wolff (MIT), Len Brillson (Ohio State, formerly Xerox Corp) and Mark Holtz (Texas Tech) describing programs that provide students with an opportunity to work closely with industry as part of their graduate experience. Speakers described the programs, discussed the mechanics of establishing internships and answered questions from the audience. Peter Abbamonte (graduate student from UIUC) provided a graduate student perspective with his description of the student-initiated career programs at the University of Illinois. Although not on the formal program, Carol Livermore and Philip Fisher, physics graduate students at Harvard University, offered additional suggestions on how students can take matters into their own hands. Brian Schwartz of Brooklyn College discussed offering course work on job preparedness. Schwarz also described a NSF-funded program to develop courses that teach students about resume writing, interview preparedness and researching the job market.

The difficulty faculty encounter in advising students about career paths other than their own was highlighted by the last section of talks. Len Brillson offered his perspective on the differences between academia and industry based on his career at Xerox prior to becoming a faculty member at The Ohio State University. John Lowell of Applied Materials, Inc. provided a similar perspective as he discussed his perception of differences between in-

(continued on page 8)

MEMBER IN THE Spotlight

Massey Adopts "Old Style" Approach to Morehouse Presidency

Upgrading campus computers, creating interdisciplinary courses, and serving burgers and fries in the cafeteria to better interact with the student body are just some of a typical day's activities for physicist Walter Massey. A former APS vice president, Massey left a prestigious position at the University of California System nearly three years ago to become president of Morehouse College, the nation's only historically black, liberal arts college for men, claiming his desire to return to his alma mater and a presidency that fosters relationships with students.

Massey's interest in science dates back to his childhood in Hattiesburg, Mississippi. The young Massey was quite keen on mathematics in high school, and at the age of 16, he enrolled in a Ford Foundation program for early admission of qualified young black men to Morehouse. There, he was introduced to the world of science by one of his early professors and mentors, Henry McBay, a nationally recognized figure within the black scientific community who taught a required introductory chemistry course. But it was his first physics instructor, S.H. Christensen, who influenced his decision to make physics his career. "It was cleaner, with no messy labs or chemicals, and there was a stronger mathematics component," says Massey of his choice of profession.

Massey earned a bachelor's degree in both physics and mathematics in 1958. That same year, his mother, Essie, an elementary school teacher whom he credits with teaching him the value of education, also earned a bachelor's degree in education, from Jackson State University. Massey says he was intrigued by physics because it combined mathematical problem-solving with understanding the physical world. He pursued graduate studies at Washington University in St. Louis, Missouri, completing his Ph.D. in physics in 1966, specializing in analyzing the properties of quantum solids and liquids at very low temperatures.

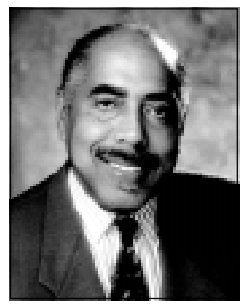
Eventually he landed at Brown University as professor of physics and dean of the undergraduate college, a period he describes as one of the happiest of his career, largely because of the substantial contact he had with both students and faculty. Prestigious positions as director of Argonne National Laboratory, vice president of research at the University of Chicago, director of the National Science Foundation, and vice president of the University of California followed, and while Massey continued to excel, he missed the close interactions with students and faculty. This was a major factor in his decision to leave the University of California and assume the presidency of Morehouse, his alma mater, in 1995. "Part of returning was to make a statement that Morehouse and schools like this are able to attract people from major universities," he says. "It was not an easy decision, but it was the right one. Now that I'm back, I know that."

Massey takes his commitments to the student body and faculty seriously. He set up an elected Faculty Council to allow faculty members to take part in policy decisions. He holds regular meetings with the Student Government Association officers and has begun a series of "Presidential Chats," in which community and business leaders take part in informal talks with students. He also teaches from time to time, drawing on his national administrative experience to lead a seminar last year on science and technology policy. To encourage more interaction between students and faculty, he tore down the cafeteria wall separating the two dining areas. Nor is Massey above serving burgers, fries and pasta in the cafeteria himself.

In keeping with the Morehouse tradition of cultivating future world leaders, Massey is raising money to establish a Leadership Center, which will offer seminars and classes on leadership, and will be accessible to students attending the five other members of the Atlanta University Center, a consortium of historically black colleges. And, in addition to bulking up programs in African-American and international studies, he and the provost, John Hopps, a physicist and his college roommate, have established interdisciplinary programs in neuroscience and materials science through partnerships with other colleges and universities, among them Georgia Tech, Princeton, and Brown University.

Massey has also been instrumental in preparing the institution for the 21st century. The college is completing a $4.5 million investment in technology, installing fiber optic cable networks campus-wide so that even the dorms are now wired for computers. A standardized computer base has been created, with major hardware and software upgrades for the institution's administrative computer systems for such functions as registration and financial aid. A new Office of Information Technology was established to manage the computer operations and to set up training courses for students, faculty and staff. And the new Office of Educational Technology works with faculty on ways to incorporate computer technology into their courses for instructional purposes.

Massey's broad background has certainly given him some advantages in meeting the challenges of his new position. "I've had the opportunity to learn a great deal, not just about administration, but about many of the issues affecting higher education, and I've seen them from a number of perspectives, which certainly helps me deal with those issues here," he says. An issue of particular concern to Massey these days is the possible diminishment or dismantling of affirmative action policies at many state schools.



For example, California recently passed Proposition 209, which eliminated all affirmative action in the state, and the U.C. System's Board of Regents voted to discontinue all forms of preferential treatment — two measures that Massey believes will make it difficult to maintain diversity in the U.C. system. His suspicions have been borne out by the fact that minority enrollments at the University of California have significantly decreased following the passage of Proposition 209.

"I think this starts from a wrong assumption that being admitted to college is a reward for achieving high grades and high test scores," says Massey of the decision, which he vigorously opposed. "But we used all kinds of different criteria for admitting students to U.C. And when we looked at the evidence, there was no great disparity between what the minority students did in terms of careers and graduate school when they left the U.C. system and what the white students did." In fact, he points out that under the new rules many black and Hispanic students with excellent GPAs and high test scores were nevertheless denied admission, despite their achievements. In the short term, of course, colleges like Morehouse are benefiting as students denied admission to public-college campuses in California and Texas seek more appealing alternatives. In fact, California is Morehouse's second-largest feeder state, following its home state of Georgia.

APS News

Coden: ANWSEN ISSN: 1058-8132
Series II, Vol. 7, No.6 **June 1998**

Editor: **Barrett H. Ripin**
Newswriter: **Jennifer Ouellette**
Production: **Elizabeth Buchan-Higgins**
Kim Parsons
Alicia Y. Chang
Coordinator: **Amy Halsted**

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 $20. **Nonmembers:** Subscription rates are: domestic $160; Canada, Mexico, Central and South America, and Caribbean $180; Air Freight Europe, Asia, Africa and Oceania $210.

Subscription orders, renewals and address changes should be addressed as follows: **For APS Members**—Membership Department, The American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org. **For Nonmembers**—Circulation and Fulfillment Division, American Institute of Physics, 500 Sunnyside Blvd., Woodbury, NY 11797. 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, The American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

IN BRIEF

APS Committee Sponsors Petition

The APS Committee on International Freedom of Scientists (CIFS) has jointly sponsored a petition on behalf of 18 physicists and other scientists in the People's Republic of China, who have been imprisoned or mysteriously "disappeared" because of their exercise of freedom of expression. Signature drives were held at both the March and April APS general meetings. Among the physicists listed were Zhu Xiangzhong, whose release has not been confirmed despite the expiration of his prison term, and Lu Yangua, a graduate student at Lanzhou University detained in 1992, who is believed to have been secretly tried and sentenced. Co-sponsors of the petition include the AAAS Committee on Scientific Freedom and Responsibility, the New York Academy of Science's Committee on the Human Rights of Scientists, and the Committee of Concerned Scientists. The petition is also endorsed by the Academic Freedom Committee of Human Rights Watch.

Ohio Section holds its Annual Spring Meeting

The APS Ohio Section held its annual spring meeting, May 1-2, at Ball State University in Muncie, Indiana, in conjunction with the Indiana and Southern Ohio Sections of the American Association of Physics Teachers. The program featured five invited speakers. Leon Lederman, director emeritus of Fermilab, addressed current issues in K-12 physics education. Philip Sadler of the Harvard-Smithsonian Center for Astrophysics, discussed several common misconceptions in physics. Mark Trodden of Case Western University summarized the status and future of particle cosmology. Speaking on the topic of the "Mars Direct" was Robert Zubrin, president and founder of Pioneer Astronautics, a space-exploration R&D firm. Finally, Alfred Hubler of the University of Illinois described a special feature of his introductor physics courses called "CYBERPROF" — a Web-based homework grading system.

Members to Vote on Proposed Amendments to APS Constitution to Allow Electronic Balloting

At its April meeting, the APS Council approved several amendments to the Constitution, which will appear on the election ballot this summer for APS members to vote on their adoption. The amendments are presented here to the membership, and comments are invited. These should be sent by e-mail (halsted@aps.org), regular mail, or fax (301-209-0865) to Amy Halsted at APS Headquarters. Please respond by September 4. The amendments under consideration are necessary to permit electronic ballots in future membership-wide elections and for proposed Constitutional amendments. The rationale for electronic balloting is increased voter participation, lower expenses, and gentler environmental impact because paper ballots would not need to be mailed to every member. Confidentiality and accuracy of electronic ballots would be assured. For the forseeable future, members preferring to vote on a paper ballot would retain that option. The entire Constitution can be viewed on the APS Home Page or in the latest issue of the APS Directory. New text appears in ***bold italics***; text to be deleted appears in ~~strikeout~~.

ARTICLE VI - EXECUTIVE BOARD AND COMMITTEES

2. **Nominating Committee**. - …The Chairperson-Elect shall be elected annually by ***ballots cast electronically or by mail*** ~~mail ballots~~ as described in Article VII.5…

ARTICLE VII - ELECTION AND TENURE OF COUNCILLORS, OFFICERS, AND ELECTED COMMITTEE MEMBERS

2. **Ballot**. - The Vice-President, Chairperson-Elect of the Nominating Committee, and Councillors shall be elected by ***ballots cast electronically or by mail*** ~~mail ballots~~ as hereinafter provided.

5. ***Election*** ~~**Mail**~~ **Ballot**. - The election ballot shall contain the names of at least two candidates for each vacancy to be filled, clearly separated according to category: ViceÿPresident, ChairÿElect of the Nominating Committee, and General Councillors. Copies of the election ballot shall be ~~mailed~~ ***provided*** to all members of the Society ***by mail or electronically*** at least five weeks prior to the Elections Meeting of Council. No ballot shall be counted unless unambiguously ***filled out*** ~~marked~~ by a qualified voter, ***cast electronically*** or sent in a sealed envelope bearing the voter's name, and received at a specified ***location*** ~~address~~ not later than the specified deadline date…

ARTICLE XIII - AMENDMENTS

No part of the Constitution shall be amended or annulled except by a vote of the membership by ***ballots cast electronically or by*** mail ~~ballot~~…The text of the proposed amendment shall be published in a publication of the Society before ballots are ***distributed*** ~~mailed~~…The Executive Officer shall distribute the ballot and a copy of the proposed amendments to all members of the Society and shall specify ***a location*** ~~an address~~ to which the ballots are to be sent and a deadline date not less than five weeks later than the date of the distribution of the ballot. No ballot shall be counted unless unambiguously ***filled out*** ~~marked~~ by a qualified voter, ***cast electronically or*** sent in a sealed envelope bearing the voter's name, and received at a specified ***location*** ~~address~~ not later than the specified deadline date…

1998 March Meeting Highlights *(continued from page 1)*

in such flows is directly analogous to the density of vortices, the whirlpool-like eddies that can exist in a fluid. This approach has enabled them to study phenomena such as the formation of "vortex crystals," repeating patterns of vortices that can stay frozen in place in the fluid.

Eberhardt Bodenschatz of Cornell University reported on another new method that enables physicists to track in detail for the first time the accelerations of a particle moving through flows with atmospheric-level turbulence. He described how a light-sensitive diode measured the movements of a particle jiggling through a fluid at up to 200 times the acceleration of gravity. For a preview of upcoming experiments, the group has installed a "silicon-strip detector" used in high-energy physics to make up to 100,000 measurements per second of multiple particles in the fluid, the better to study how particles that are initially close together move apart in a very turbulent flow such as a volcanic eruption.

Weird Behavior in Quantum Dots. Interesting things happen when particles are confined in a tiny box. Researchers at MIT, led by Raymond Ashoori, make themselves such a box, a quantum dot, out of semiconductors: a layer of gallium arsenide between layers of aluminum gallium arsenide. On top of this sandwich sits a metal gate electrode which feeds electrons into the dot and controls the arrival or departure of electrons one at a time. Building up from just one electron, the MIT physicists collect a puddle of electrons and observe how the arrival of each newcomer must overcome (with the help of an increasing voltage) the mutual repulsion ("Coulomb blockade") of those already in place.

For small dots (0.2 microns across) a graph of charge-vs-voltage would look like a staircase. Such an effect is at the heart of single-electron transistors (SET), which act as sensitive detectors of electrical charge (just as superconducting quantum interference devices — SQUIDS — are sensitive detectors of magnetic flux). For larger dots (1 micron across) the MIT scientists were astonished to observe an unexpected and mysterious pairing: for each stepwise voltage increase not one but two electrons were able to join the puddle. The pairing has not yet been explained but might have something to do with the electrons' spins. For medium-sized dots (0.5 microns) the physics gets even weirder: the pairing occurs only for every fourth or fifth electron. The goal now is to understand how small puddles coalesce into larger puddles and how the pairing comes about.

Magnetic Refrigeration. In a new type of refrigerator, physicists have exploited the fact that the rare earth element gadolinium (Gd) has a large "magnetocaloric effect": applying a magnetic field to a chunk of gadolinium

(continued on page 10)

A century of physics

1925-1934: The Language of the Atom

by Hans Christian von Baeyer

The Roaring Twenties were a boisterous era of prosperity, fast cars, jazz, popular radio, and illegal drinking. Before they ended in 1929 with the crash of the stock market that triggered the Great Depression, the twenties produced such human and technological accomplishments as the invention of television and the jet engine, and the first transatlantic solo flight by Charles Lindbergh in 1927. Out of range of public clamor, this exhilarating atmosphere also produced what might be called the greatest achievement in the history of physics: the development of quantum mechanics. Frustrated by the inconsistencies of the patchwork quantum theory pioneered by Einstein and Bohr, the 23 year old German physicist Werner Heisenberg (right) set out to start from scratch. In the summer of 1925 he decided that atoms should be described without assuming anything about immeasurable quantities such as the positions and speeds of electrons inside atoms. Instead, he arranged the measurable quantities, such as the discrete frequencies of light emitted by the atom, in arrays of numbers not unlike spreadsheets. By manipulating these spreadsheets, which mathematicians call matrices, Heisenberg was able to recover the successes of the older quantum theory, without encountering its contradictions.

Photo from the Niels Bohr Library.

Werner Heisenberg

Heisenberg's matrices give the right answers, but convey no visual image of the interior of the atom. In the winter of 1925-26 the Austrian physicist Erwin Schrödinger succeeded in finding a more intuitively appealing description. In this approach, de Broglie's waves are solutions of an equation which came to be called the Schrödinger equation. Discrete colors of light emitted by glowing matter are due to the fact that electron waves confined in an atom have specific frequencies, just as sound waves inside a flute can only resonate with discrete frequencies.

The culmination of the story of the birth of the new theory came with Schrödinger's amazing proof, in March 1926, that his and Heisenberg's formulations, which appeared so different, are actually mathematically equivalent. Henceforth quantum mechanics, in either guise, replaced Newtonian mechanics as the correct description of atomic particles. It incorporates wave/particle duality and substitutes probability for certainty in dealing with the building blocks of matter. It broke with classical physics even more radically than Special and General Relativity — but for three quarters of a century it has passed all experimental tests.

Editor's Note: A CENTURY OF PHYSICS, a dramatic illustrated timeline wallchart of over a hundred entries on eleven large posters is intended for high schools and colleges. Each poster covers about a decade and is introduced by a thumbnail essay to provide a glimpse of the historical and scientific context of the time.

In July, APS News will feature the fifth introductory essay:
1935-1945: Physics in WWII.

Contributions of 20th Century Women to Physics

In commemoration of the APS Centennial, Nina Byers, working with the APS Committee on the Status of Women in Physics, has established an on-line archive featuring the many contributions of 20th Century women to physics. It has been funded by the APS, UCLA, NIST, a private philanthropist and a grant from the Alfred P. Sloan Foundation. The site currently contains approximately 50 citations, many of which are hyperlinked into other databases, including Encyclopedia Brittanica Online, which has incorporated archive pages for more than a dozen famous physicists, including Marie Curie, Irene Joliet Curie, Lise Meitner, Chien-Shiung Wu, Jocelyn Bell Burnell, Dorothy Hodgkin, Kathleen Lonsdale, and Maria Goeppert Mayer. The site has proven popular: between October 29, 1997 and November 6, 1997, close to 1000 visitors logged into the archive from all over the world, and the number continues to rise steadily, according to Byers (University of California, Los Angeles). The content and direction of the archive is administered by an archive steering committee.

Along with the citations, the archive staff has also compiled a collection of primary materials unavailable to most researchers, providing insight into the lives and careers of selected women physicists, as well as key data unavailable in conventional reference books. Also in development are a series of historical essays, the first set focusing on the gender discrimination encountered by women in Germany between 1890 and 1940. Subsequent essays will seek to place such issues into proper historical context, detailing German industrialization, the rise of Nazism, and the development of nuclear physics, among other events.

In terms of eventual disposition, Byers reports that the UCLA Library has indicated interest in acquiring the archive in both digital form and as archival documents as part of its permanent collection, ensuring continued access to the information via the World Wide Web. Thus, a visitor to the archive will have access not only to the information stored therein, but to related materials in the entire University of California library system. "It is advantageous because the UCLA library staff is first rate, their standards are very high, and because their participation in our work toward completion will greatly improve the quality of the archive," said Byers. Already under discussion are plans to design and construct an object-oriented database for the organization of the archive, greatly improving its search and retrieval capabilities.

Quantum Computing Holds Promise of Parallel Calculations

Quantum computers are hypothetical machines that would exploit the superposition principle of quantum mechanics to perform an immense number of calculations in parallel. Certain calculations in particular, such as factorization of a very large number, could be done much faster on a quantum computer than on a conventional classical computer. At the APS March Meeting, several physicists discussed the latest efforts towards building a practical quantum computer, a device that uses quantum particles (such as ions or photons) to represent the 0s and 1s (the binary digits, or "bits") employed in computations. Unlike ordinary bits, quantum bits (or "qubits") can represent 0 and 1 simultaneously.

According to Richard Hughes of Los Alamos National Laboratory, the quantum mechanical concepts on which the technology is based were first applied to computation by Paul Benioff, Richard Feynman, and others in the early 1980's. The idea was based on the observation that ordinary, classical, computers follow definite histories in the course of any computation. If one could have a quantum mechanical machine capable of following many histories at the same time, and associate a different computation with each history, one would have a way of doing many calculations in parallel. The next major development came in 1994 when concrete quantum algorithms were found for solving such interesting problems as factorization. This transformed the subject from a curiosity to one with potential for real applications.

Many schemes have since been proposed for building a real quantum computer. Although primitive devices have already been built, a likely scheme for an advanced design would be to trap a string of ions with electromagnetic fields and then use laser beams to manipulate the ions' quantum states and carry out calculations, according to Peter Zoller of the University of Innsbruck, a theorist who co-authored this proposal in 1995. Depending on the computation to be performed, a precise sequence of laser pulses is applied to the ions, which are excited and de-excited in an intricate dance that can only be described in terms of coexisting histories.

Some experimental progress has been made towards realizing this scheme. Having cooled and trapped a string of 5 ions, Hughes and several LANL colleagues have demonstrated that they can point a laser beam at an ion without disturbing its neighbors (the closest of which are 20 microns away). Jeff Kimble of Caltech has been experimenting with an alternate approach in which the qubits are photons trapped between a pair of mirrors.

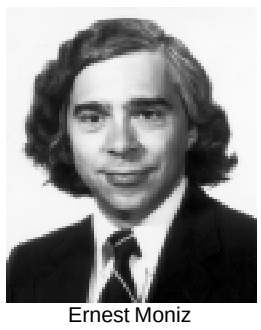
However, the performance of any real quantum machine will be limited by decoherence, which is a by-product of the same superposition principle that leads to the possibility of quantum computation in the first place. A classical computer can be halted and inspected in the midst of a computation. A quantum computation, by contrast, must be allowed to proceed to completion before any read out is performed. The problem is that it is near impossible to prevent accidental read-out.

Decoherence in the ion trap computer arises from two sources: spontaneous emission of radiation, and vibrations of the ions. The estimated theoretical decoherence in a proposed machine based on arrays of ions driven by precise sequences of laser pulses is surprisingly quite low, and of different origin depending on the size of the computer. Small-sized computers will most likely be limited by spontaneous emission in which the ions radiate light randomly into the surroundings, while larger computers suffer more from vibrations of the ions, which produce tiny electric fields that disrupt each others dynamical behavior.

"Although present-day technical difficulties in building quantum computers are enormously daunting, we know of no fundamental principle of physics standing in the way," Zoller concluded.

DOE Adjusts Mission Priorities to Meet New National Goals

The nation's current economic prosperity is leading to an emerging bipartisan consensus in favor of investing in scientific research and development, according to Ernest Moniz, Deputy Under Secretary of the U.S. Department of Energy (DOE). Moniz gave an unscheduled presentation at the APS March Meeting detailing the agency's new role in meeting the myriad of economic, scientific and technological challenges currently facing the nation.


Ernest Moniz

Moniz identified four primary national goals that underlie federal support for scientific research and education: prosperity, health, national security, and environmental stewardship. While security and health concerns fueled much of federal investment in science and technology during the post-World War II period, emphasis has shifted today to maintaining economic prosperity and preserving the environment. Security concerns remain, but the prevailing issue today is how to control the existing stockpile of nuclear weapons and materials, through such initiatives as the Comprehensive Test Ban Treaty. "The paradigm is entirely different," said Moniz of the DOE's role in this new environment. "We are now in a regime where the focus is on supporting a safe, reliable and shrinking stockpile through the construction of a new set of science facilities to achieve a new kind of scientific understanding."

The DOE is also involved in activities supporting the health sector, where there is a growing intersection between the physical and life sciences. Moniz cited the DOE's involvement in the Human Genome Project and its support of microbial genomics research as evidence of the agency's leadership in this area. And energy-related R&D is a strong focus for both environmental and economic initiatives.

Regarding national prosperity, Moniz considers sustaining innovation as critical, particularly as the private sector restructures and lowers its investment in R&D. "The question is, what is the government's role in helping sustain innovation?" he said, maintaining that a healthy business environment, while important for stimulating innovation in the private sector, is equally important for stimulating government investment in science and technology. "The Administration's posture, it is fair to say, is that this is the time to invest," said Moniz. "We have had several years of economic growth, we've reached a balanced budget, and our economy is currently out-performing the rest of the world. This is not a time to relax, but to refocus on investments for the future."

As evidence of the Administration's interest, Moniz cited such presidential investment initiatives as the Environmental Research Fund, the Transportation Fund for America, and especially the $31 billion Research Fund for America, an initiative which proposes an 8% increase in investment spending from 1998 to 1999. The nearly $1.5 billion proposed increase in R&D spending includes $338 million for energy technology R&D, especially related to climate change; $420 million for defense programs largely tied to scientific instrumentation programs connected with stockpile stewardship; and nearly $250 million in scientific energy research, roughly half of which is allocated for next year's proposed construction of the megawatt Neutron Spallation Source at Oak Ridge National Laboratory.

"The DOE has a unique responsibility for building and operating large science facilities, which serve many thousands of university and industrial scientists," said Moniz, citing technology and resource partnership programs as other DOE activities benefitting academia and industry. In terms of future facilities, 1999 will witness the completion of the Relativistic Heavy Ion Collider at Brookhaven, as well as the Solar Neutrino Observatory in Ontario and the beginning of the Princeton's National (Spherical Jorus) Experiment (NSTE).

In the field of particle physics, the B-factory at SLAC will become operational within the next couple of years, enabling studies of B meson decay change, CP violation and particle asymmetry. At the same time, Fermilab will complete its Main Injector, increasing luminosities sufficiently to study the top quark regime in great detail, possibly leading to the discovery of the Higgs boson. It will remain the premier high energy physics facility for the next several years until the middle of the next decade with the completion of the Large Hadron Collider at CERN, representing a ten-year DOE investment of $450 million. This, said Moniz, "will hopefully establish the beginning of what will prove to be a sustained international collaborative effort on large facilities."

Moniz concluded his presentation by reiterating his enthusiasm about the current scientific capabilities and opportunities, saying he was "encouraged" by the emerging bipartisan consensus in Congress on investment in science and technology. However, he stressed that the federal budget environment remains difficult and the scientific community must continue to be involved in these discussions on the Hill. "Now is the time to invest and build up our scientific infrastructure," he said.

"Spintronics" Hold Potential for Future Electronic Devices

Scientists at the Naval Research Laboratory are researching characteristics of several spin-dependent phenomena in the hope of eventually exploiting such effects to develop new types of devices and circuits for very high-performance electronics and sensors ("spintronics"). The technology project is sponsored by the U.S. Defense Advanced Research Projects Agency (DARPA). One near-term goal is the development of a totally nonvolatile, very high-density, high-speed, low-power, low-cost memory device that has the potential for significantly exceeding the performance of traditional semiconductor-based memories, and may represent one of the major technologies for the 21st century.

"Ultimately spintronics may provide the technology for much more than memories and sensors and may become as ubiquitous as semiconductor electronics in the next century," said NRL's Stuart Wolf, who spoke at the APS March Meeting in Los Angeles. Wolf described two such effects: giant magnetoresistance (GMR), in which the electrical resistance that electrons experience in a multilayered material can be substantially changed by the magnetic field within the material, and spin-dependent tunneling, in which an electron can move through a normally impenetrable barrier if it has the right spin value.

The movement of an electron in a circuit can also be manipulated by properties other than its charge. One example is spin, which according to Wolf, the simplest device using spin-dependent effects is a sandwich with two magnetic layers surrounding a nonmagnetic metal or insulator. If the two magnetic layers are different, then the magnetization direction of one can be rotated with respect to the other and this leads to the utilization of these structures as sensor elements (for example for read head sensors) and for memory elements that may ultimately rival the semiconductor memories that now dominate commercial computers. Recently, IBM introduced GMR sensors into the read head of the newest generation of its hard disk products.

IBM, Motorola and Honeywell all have research teams attempting to develop a robust technology to use these devices to produce very high density memory products — comparable to dynamic random access memory — at speeds approaching those obtainable in static random access memory (SRAM), with fewer masking steps and lower power. Honeywell has already demonstrated a fully functional 16-kbit GMR memory, built with underlying electronics that can withstand the high radiation environment of satellites required, and Wolf hopes the technology will be in place for Gbit memories early in the 21st century. IBM estimates that their devices will scale to densities greater than 50 Gbit.

Wolf also described spin injection devices, in which the spin of an electron can modify the properties of a material into which it is injected. The "spin transistor" invented in the early 1990s is such a device. The desired spins are injected into a normal metal by passing a current from the magnetic metal to the normal metal. The spin-injected current induces a local imbalance in the spin-up/spin-down ratio, which can be detected by a nearby magnetic film.

If the detector film is magnetized in the same direction as the injector, the imbalance can relax by current flowing from the normal material into the collector. However, if the films are magnetized anti-aligned, the relaxation of the imbalance occurs by a current flowing from the collector into the normal metal. Thus the direction of the current (and subsequent voltage) depends on the direction that the detector is magnetized relative to the injector. This "bi-polar" device can be made into memory and logic devices.

Task Force for Prizes and Awards Issues Report

APS prizes and awards are highly regarded by the scientific community and represent a wide range of disciplines, according to a report of the Task Force on APS Prizes and Awards delivered to the APS Executive Board in February. The report also states that there is a good match between the set of awards and the needs of the physics community. Nonetheless, the report also recommended steps intended to broaden the criteria for such honors to encourage more nominations, and suggested that new proposals for prizes and awards should be accepted only if they will benefit the overall portfolio without overlapping existing prizes and awards.

Chaired by Mildred Dresselhaus of the Massachusetts Institute of Technology, the task force was charged with three major tasks: assessing the various prizes and awards to determine whether all sectors of the physics community were represented; providing advice to the APS Executive Board on whether to accept funding for additional prizes and awards, if offered; and considering whether existing criteria for prizes and awards should be broadened to encourage more nominations. Numerous other topics were also considered during the group's deliberations, including the establishment of minimum monetary amounts, policy on multiple recipients, and under which conditions an individual may receive more than one prize or award.

The task force suggested numerous criteria for consideration of proposals for any new prizes or awards. These include whether such honor covers a major field of interest, whether a prize already exists for this area, whether the proposal includes provisions for travel and expenses for recipients to attend the meeting at which the prize or award is presented, and whether it provides for a general review after a specific period of time to determine the continued relevance of the subject area and award.

With regard to broadening the criteria to encourage more nominations, the task force encouraged equal access to all prizes and awards in its report, without limitations on nationality or geographical location, or even APS membership. In fact, it was felt that the APS should require units with an interest in the discipline associated with the honor to review the suitability of its description to eliminate unnecessary restrictions. The review should be completed and submitted in written format within the next two years, according to the task force recommendations. To further encourage breadth, selection committees should discuss pre-eminent candidates for possible future nomination after selecting the current year's recipient. These potential candidates include foreign, minority and women candidates, as well as those previously nominated whose nomination has expired.

The task force made several other recommendations upon considering ancillary topics. For example, it was recommended that individual APS units be responsible for oversight of thesis awards, using the present model employed by the Division of Atomic, Molecular and Optical Physics to select award recipients.

In addition, the task force recommended that all stipends for major prizes — currently ranging from $5000 to $10,000 — should be raised to $10,000 within the next five years. This recommendation is currently under review by the APS.

With regard to multiple recipients, single recipients should still be encouraged, unless sufficient justification is submitted to the APS Executive Board for awarding an honor to multiple individuals. To this end, selection committees are strongly encouraged to recognize only prime contributors to large team collaborative works, especially those involving more than one institution. "Only those who have made unique, original and indispensable contributions should be named as prize or award recipients," the task force concluded in its report. Furthermore, one individual should not receive more than one major APS prize for the same work, although a past award recipient would not be ineligible for subsequent recognition for a major prize if it is demonstrated that the work has been extended significantly.

Finally, funds associated with each prize and award should be available to cover travel expenses for recipients to attend the meeting at which they will be honored. Many prizes and awards already follow this procedure, but henceforth the task force recommended that those awards which do not specifically include such a policy should be structured to do so, unless other arrangements are stipulated. However, units may choose to pay recipient travel expenses directly rather than charging the prize or award fund. The task force report concluded with recommendations that the APS continue its practice of not charging overhead for administration of the prize and awards program; and that a standing oversight committee is not necessary to oversee this program, although a task force should be appointed every five years to review policy issues.

The other members of the APS Task Force on Prizes and Awards are Ronald Davidson, Princeton University; Katharine Gebbie, National Institute of Standards and Technology; Wick Haxton, University of Washington; Rolf Landauer, IBM/T.J. Watson Research laboratory; John Rowell, John Rowell, Inc.; and Frank Sciulli, Columbia University.

Council Proposes Bylaw Revision for Thesis Awards

In accordance with a recommendation from the 1998 Task Force on Prizes and Awards, Council has approved a revision to the APS Bylaws regarding the thesis awards bestowed by several APS Divisions. The Bylaws state at present that prize and award recipients shall be approved by the Executive Board but Council voted to allow units to present thesis awards without this approval. The rationale for the revision is that some divisions understandably wish to select winners and present these awards at their annual meetings, immediately following competitive presentations from the candidates. The revision appears below in *bold italics*. Comments are invited from the membership. These should be sent by e-mail (halsted@aps.org), regular mail, or fax (301) 209-0865 to Amy Halsted at APS Headquarters. Please respond by September 4.

ARTICLE IV - PRIZES AND AWARDS

2. Approvals.-The Council shall approve the criteria for all Prizes and Awards awarded by the Society. Individual recipients of Prizes and Awards shall be approved by the Executive Board, *with the exception of any dissertation awards bestowed by Divisions or Topical Groups*.

MEMS Could Pave the Way for Atomic-Scale Assembly

Microelectromechanical systems (MEMS) could provide the key to manufacturing atomic-scale, self-assembling devices of the sort presently observed only in nature's complex living organisms. Often built with the same materials and lithographic techniques used in making integrated circuits, micron-sized MEMS motors, pumps, resonators, actuators, and sensors have been developed in the lab but not yet much deployed in marketable devices.

However, this may be changing soon. Michael Roukes of Caltech leads an effort focused on creating and exploring the properties of simple nano-electromechanical devices (NEMS), which have already proven useful in improving MRI sensitivity and wireless communications. The latter will most likely be crucial to future space exploration. At the APS March Meeting in Los Angeles, he specifically described the effort to coax small suspended columns of silicon into vibrations at GHz frequencies, making them into possible radio wave transmitters.

Using lithography and etching techniques, he has fabricated a 10x10x100-nm suspended beam of silicon which oscillates at an estimated frequency of 7 GHz (although no detector can yet "hear" the vibrations). Such a resonator will eventually be used in microwave signal processing (for modulating or filtering signals). The speed and stability of nanoscopic silicon arms might even facilitate the advent of some new kind of Babbage-type computer in which mechanical levers once again serve as processing or memory elements. Silicon structures in this size regime will also be used as cantilever probes in magnetic resonance force microscopy — the goal being atomic-resolution NMR imaging — and as calorimeters for the study of quantized heat pulses.

Roukes' colleague, Andrew Cleland (University of California, Santa Barbara), described a paddle-shaped silicon structure (whose smallest lateral feature was 200 nm) for detecting very small amounts of electrical charge, with a potential application in high-sensitivity photodetection. At the same session, Rex Beck of Harvard reported a NEMS force sensor which integrates a field effect transistor into a scanned probe microscope. The present sensitivities are about 10 angstroms for displacement and 5 pico-Newtons for force, but Beck expects improvements as the size of the device shrinks. The smallest transistor-probe structure Beck reported had dimensions of 3x2 microns x 140 nm. Stanford's Thomas Kenny reported on the use of slender cantilevers in atomic force microscopes to measure forces at the attonewton (10^{-18} newton) level.

MEMs may be a key enabling technology for NASA to explore the solar system with ultra-miniaturized, robust, softball-sized spacecraft, one of the most promising application areas. JPL scientist William Tang described the integration of microgyroscopes, microseismometers, quadrulpole mass spectrometers, micropropulsion engines and other sub-pint-sized gadgets on future space missions. When successful, these devices will serve as models for developing components and systems for spacecraft in the new millenium. "Space exploration in the coming century will emphasize cost-effectiveness and highly focused mission objectives," said Tang, who believes this new approach should result in frequent multiple missions, which will be faster, better, smaller and cheaper. "The aim is to broaden the scope of space science and to validate new technologies on a timely basis."

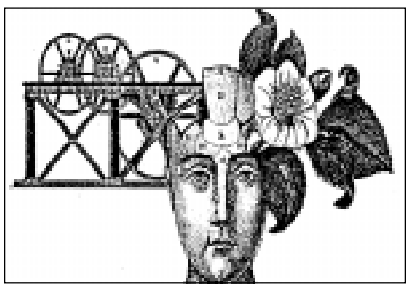
Dennis Polla (University of Minnesota) has deposited ferroelectric thin films on silicon-based MEMs to make sensors and actuators with a broad range of applications. These include acoustic emission sensing in integrated diagnostics; measurement of acceleration; biochemical sensing using molecular recognition microcantilevers; miniature stepper motors for precision positioning; and surgical and scientific micro-instruments. Chih-Ming Ho (University of California, Los Angeles), reported on recent studies of microscale fluid flows, in which the surface force dominates the force field, although, said Ho, other experiments indicate that the viscous force alone cannot account for the observed results.

Ultimately, MEMs research and the ensuing devices are expected to provide possible foundations of nanotechnology and the so called "Holy Grail" of atomic-scale assembly. "When we get there, nanotechnology will provide techniques for the mass production of tiny functional machines assembled, atom-by-atom, with perfect precision," said Rourkes. "But right now, Mother Nature is really the only true nanotechnologist.

APS VIEWS

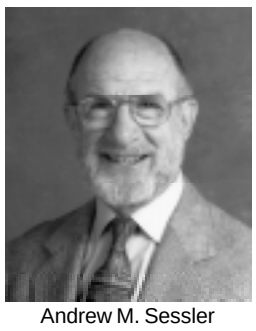
THE WEALTH OF NATIONS

by Andrew M. Sessler, APS President and Francis Slakey, APS Public Information

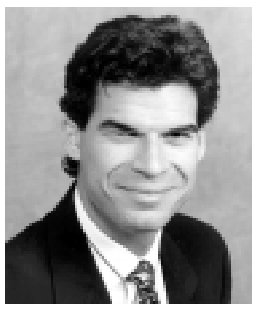


A version of this editorial appeared in the San Francisco Chronicle on March 20, 1998

There was a time when a nation's future was determined simply by its store of gold. Those kingdoms faded, and their warriors' armor now hangs in dusty museum cases. Today, a nation's wealth is measured by its scientific ideas, and the idea warriors are trained in university laboratories. The chiefs may be in Washington, but in March the warriors came to California for the largest physics meeting in the world.



Andrew M. Sessler



Francis Slakey

A century ago, science was still in the backwash of government priorities. The President would have been thrown into an asylum if he claimed to see a future where the top three diseases were eradicated and our life expectancy doubled. Yet, it all came about — even if we do still stub our toes getting out of bed in the morning. Moreover, the nations that pursued those scientific ideas are now the most prosperous in the world.

The government gave civilian science a whirl fifty years ago. One early investment was $50,000 toward creating a new source of microwaves. At the same time, Bell Labs let a few obscure scientists tinker with paper clips and germanium. Out popped the laser and transistor, and eventually Silicon Valley's semiconductor industry. That industry is now the heart of California's economy. To the rest of the nation, it's the very identity of California. OK, so maybe surfing is.

Today, the scientific challenge resonates with scores of politicians. Last October, four Senators wrote a bipartisan bill to double the federal investment in science over ten years. In February, they wrote to their colleagues, explaining how science "drives future economic growth." By mid-March, they had netted eight more co-sponsors, including both California Senators.

The Administration is also talking science. In the State of the Union Address, President Clinton announced a "1st Century Research Fund." In February, he forecast a future "where wars on cancer and AIDS have long since been won; where the benefits of science are broadly shared in countries both rich and poor." Tall tales? Hardly. It's all quite doable stuff. If he'd said we'll tame El Niño, now that would be tough.

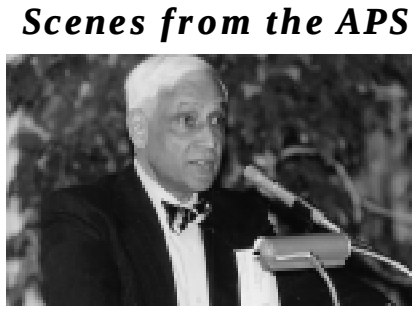
While all this was going on in Washington, scientists were busy forging new ideas. In March, they emerged from their labs and arrived in Los Angeles for a week-long clash. Five thousand physicists attended, bringing a thousand new ideas and maybe 2,000 clean shirts.

A few ideas will be closely watched by California industrialists. The semiconductor industry benefits from an astonishing engineering trend: the number of transistors that can be squeezed onto a wafer of silicon doubles every eighteen months. The steady improvement feeds the public craving for smaller, more powerful computers. The craving drives an industry that annually manufactures more transistors than the total number of raindrops that fall on California in a year. Well, maybe not this year.

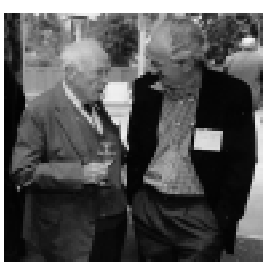
But, silicon technology won't last forever. To maintain the trend, there need to be some breakthrough scientific ideas. At the APS March Meeting, scientists from Cal Tech discussed "quantum computing" (see page 4) and "spintronics" (see page 4) — radical alternatives that could reduce transistors to the size of a few atoms. Scientists from Stanford described "holographic data storage" — a technique that could store all of Pat Boone's recordings on a single CD. That way, we could throw them all away at once.

The prosperity of the next generation will be built on a few of the scientific ideas discussed in California a few months ago. The next great industry, the next history-shaping paradigm, it starts at such meetings as a raw scientific idea. In March, we had a chance to peek at the future of the nation.

Scenes from the APS L.A. Fellows Reception



C. Kumar N. Patel (top left) organized the event held at UCLA on March 24, 1998.



LETTERS

Physics is Not Always a Benefit to Mankind

Considering that we physicists pride ourselves for being precise, I was surprised to read the amendment to the APS charter in Charles Schwartz's letter. Surprised because the new wording is obviously false. "Understanding of the nature of the physical universe", and knowledge in general, has historically not always been used as a "benefit to all humanity". A belief otherwise is simply naive. The power of knowledge, and the responsibility that comes with it, has been a central theme in many of our culture's stories, from the Garden of Eden to Frankenstein. Nevertheless, I am not an advocate of "ignorance is bliss" and still believe in the "advancement and diffusion of the knowledge of physics".

Dan Durkin, Graduate Student
UC Berkeley

❖

I support Charles Schwartz (*APS News*, April 1998, page 4) that the American Physical Society should abstain from having explicit faith-like and futurological statements in key policy documents. Such claims not only ridiculous as such but mislead general public about the inherent constrains of our profession.

Alexander A. Berezin
McMaster University, Hamilton, Canada

❖

Comment on: *Why God Never Received a PhD*

What is the rationale or the justification of the material under the rubic of *Zero Gravity* in the April 1998 issue of *APS News* ? The title indicates a jest; but to some members it is not appropriate to refer to the Creator and sustainer of the universe in this offensive manner. I have been personally acquainted with God through His Son for well over three quarters of a century. He is the source of everything good in my life, and I owe Him total allegiance. Therefore I protest strongly this libel against Him. Its author expresses opinions beyond his professional competence.

Edson R. Peck, Emeritus Professor of Physics
University of Idaho

❖

Fact or "Netmyth"?

I think the netmyth stories are generally delightful. I don't believe them, but they are great stories. Here's one for you that I think is actually quite old.

A group of 4 soldiers had dismantled a chimney on top of a two story building. The bricks were piled onto a 4 foot square board attached to a sling with a rope that went over a pulley extending from the roof. One man went down and held onto the rope while the other three pushed the load of bricks off the roof. Since the bricks weighed about 800 pounds, the 150 pound man at the bottom was pulled up when he refused to let go of the rope. He was bashed by the board on his way up (the bricks way down) and ended up crashing into the pulley on the roof. When the bricks hit the ground they scattered, leaving the 150 pound soldier supported, or not supported, by a 30 pound board at the ground. So, he came down and the board went up, naturally bashing him again on the way. When the soldier hit the ground he let go of the rope and, of course, the board came back down and hit him on the head.

Probably not a true story, but who cares? It's a good tale.

Jon Orloff
University of Maryland

❖

I just read your article about Netmyths, and I thought you might be interested in the following "news story" I received a couple of days ago. I doubt it's true, since I'd heard this as a joke 15 years ago. This is the transcript of an ACTUAL radio conversation of a US naval ship with Canadian authorities off the coast of Newfoundland in October, 1995. Radio conversation released by the Chief of Naval Operations 10-10-95.

Americans: Please divert your course 15 degrees to the North to avoid a Collision.

Canadians: Recommend you divert YOUR course 15 degrees to the South to avoid a collision.

Americans: This is the Captain of a US Navy ship. I say again, divert YOUR course.

Canadians: No. I say again, you divert YOUR course.

Americans: THIS IS THE AIRCRAFT CARRIER USS LINCOLN, THE SECOND LARGEST SHIP IN THE UNITED STATES' ATLANTIC FLEET. WE ARE ACCOMPANIED BY THREE DESTROYERS, THREE CRUISERS AND NUMEROUS SUPPORT VESSELS. I DEMAND THAT YOU CHANGE YOUR COURSE 15 DEGREES NORTH, THAT'S ONE FIVE DEGREES NORTH, OR COUNTERMEASURES WILL BE UNDERTAKEN TO ENSURE THE SAFETY OF THIS SHIP.

Canadians: This is a lighthouse. Your call.

Horst Severini
Ohio University

❖

The netmyth I wish someone would put to bed is the idea that there can be an e-mail message, recognizable by its subject line, that will fill up your hard disk with nonsense if you read it. This message never specifies which platform or operating systems are susceptible, proving that the warning can't be for real. But if we define a virus as being any computer file that exploits a weakness in the computer system to propagate itself, the warning is itself the virus that infects all platforms and operating systems. The weak point? Credulous users.

Joe Straley
University of Kentucky

Some Simple Rules of Writing

by Barbara Goss Levi

The nice thing about going into physics is that you don't have to write much — except for the grant proposal that has to convince funders to support your work or the research paper whose publication is the key to your promotion. Not to mention the general review article that explains to other physicists, or maybe even your spouse, what is so special about the work that consumes your every living hour.

Like it or not, competent writing is an important tool of the physicist. Recognizing that, a few physics departments include some kind of writing experience in the undergraduate curriculum. For example, students in the third-year lab course at Stanford University must write up each experiment as if it were a paper intended for journal publication.

Although I have written for *Physics Today* for nearly 30 years, I have never taken or taught a science writing class. So I can't say what or how one might teach communication skills to physics majors. I can only share a few rules that have stood me in good stead. I name each rule for the mentor who taught it to me.

I. Miss Ottenberg's Rule: Practice writing short summaries of longer articles. This 7th grade teacher called such a summary a "precis," a foreign word no doubt intended to impress her naive students. Miss Ottenberg regularly gave us several pages of text and asked us to boil them down to one paragraph. The exercise taught us to cut down the trees to better see the forest and forced us to write more succinctly. To make our word limit, we had to sacrifice many colorful adjectives, but along with them we jettisoned lots of imprecise and needlessly wordy phrases.

II. Mr. Orloff's Rule: Combine writing with inspiring reading. I still remember Mr. Orloff pacing the front of my high school classroom as he dramatically recited the lines of Hamlet (he was faculty adviser to the Drama Club). He also entertained us by grouping the required readings into various themes, such as humor, death and love. Stimulated by the divergent thoughts and styles of the assigned readings, we wrote essays on the given theme, no doubt trying to emulate the style of our favorite author. Maybe today's researchers and students would write better if someone held up examples of really well-written papers in *Physical Review Letters*. Every once in awhile I come across one that can be read by someone outside the narrow specialty, and it's a real treat.

III. Terry Scott's Rule: Get rid of superfluous words. When I first arrived at *Physics Today*, I received important feedback from Terry Scott, who was then managing editor of the magazine and later served the American Institute of Physics as journal publisher before his recent retirement. Among other things, he insisted I expunge wordy phrases from my stories. On the taboo list were such phrases as "there is..." or "the fact that...." As frustrating as it sometimes was not to have these phrases available to me, I soon found that the sentences I constructed without them were more lively and readable.

IV. Gloria Lubkin's Rule: Rewrite if it's not clear and define your terms. Throughout my tenure at *Physics Today*, I have had feedback from Gloria Lubkin, who founded the "Search and Discovery" news section in 1967. Especially when I first started writing for the magazine, I would feel quite annoyed when she scrawled "unclear" in the margin next to some paragraph. But when I critically re-read my own writing, I would think of more direct and effective explanations to offer the reader. The rewrite has almost always been better than the first draft. Thus, I try never to invest so much ego in my writing that I am not willing to listen to comments and drastically rephrase if necessary.

The other really annoying thing Gloria does is to circle a word and write "define" in the margin. I hate that. I have finally finished a complicated story and have become so steeped in the language of a particular subfield that I want to use its jargon. Frequently the jargon term is really complicated to explain and I am reluctant to interrupt the flow of my story to define it. On the other hand, if I stick it in unexplained, the term might just stop my reader in his or her tracks. So I am challenged to find a simpler way to say the same thing, or else completely drop the particular detail that required the jargon word, often with no loss to the overall story.

V. Experience's Rule: Good writing is clear thinking. If I have to explain the fractional quantum Hall effect in a palatable manner to a geophysicist specializing in mantle convection, I'd better be able to explain it to myself first; it has to make sense to me. That doesn't mean I have to take a course in every topic I write about, but at least I have to understand the main characteristics of the phenomenon. An even better test of how well you understand a subject is how well you can explain it to a colleague in conversation. Sometimes in staff meetings, we newsreporters summarize for one another the stories we are working on. By having to field questions from the other writers, each of us has to hone our own understanding.

None of these rules is new. They are like the simple rule to tennis players: "Keep your eye on the ball." The players all know the rule, but the challenge is to consistently follow it. And having completed this little piece, I wonder which of the above rules I have violated in writing it.

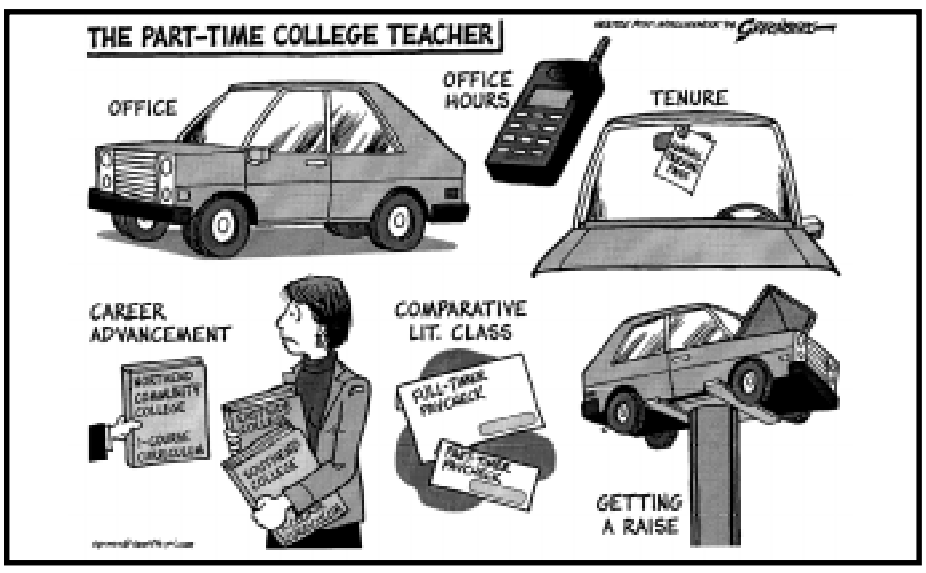
Barbara Goss Levi is a senior editor of Physics Today*, and a member of the Forum on Education's Executive Committee. This article originally appeared in the fall 1997 issue of the Forum on Physics and Society newsletter.*

APS Executive Board Appoints Task Force on Academic Tenure

The APS Executive Board has appointed a Task Force on Academic Tenure to grapple with the active and sometimes acrimonious debate on the need for change in the academic tenure system, especially since the suggested changes could have an impact on the ability of universities to perform scientific research. Furthermore, the nature of physics research careers are changing and sometimes come into conflict with current and proposed tenure procedures.

Chaired by John Poate of the New Jersey Institute of Technology, the task force is charged with examining the present trends and proposed changes in the tenure system, and assessing how these might affect the vitality of research and teaching in physics. In addition, it is being asked to consider additional studies of these issues which might be underway by other scientific societies and professional organizations, and to conclude whether the issues are sufficiently urgent to warrant an official APS statement on the subject.

The connections between tenure, academic freedom, and economic security have existed for many years, and are very strong, according to Frank Franz, president of the University of Alabama in Huntsville (see back page article). "For most people, the strongest rationale for tenure is the maintenance of academic freedom for our faculty, and the concomitant freedom from coercion or persecution," he says. "Tenure... provides a powerful buffer against arbitrary and capricious acts by administrators or, indeed, by fellow faculty members. The questions most often raised are, does that protection come at too great a cost, and, if so, are there other ways to provide it?" Franz identifies post tenure review and the burden of proof, as well as standards for the removal of tenure, as among the most important issues at stake in considerations of tenure policies. A brief report will be presented to the APS Executive Board in September, with a final report to the APS Council slated for November. The other members of the task force are Robert Gluckstern (University of Maryland); Jolie Cizewski (Rutgers University); Steve Ralph (Emory University); Raymond Brock (Michigan State University); and Roger Falcone (University of California, Berkeley).



zero gravity

How to Give a Better Physics Talk

Listed below, in no particular order, are the most important rules for giving a good talk at a professional physics meeting:

1. Carefully check each viewgraph for spelly misteaks.
2. DO NOT OVERUSE BOLD TO MAKE A POINT!
3. Absolutely no alcohol during the talk (this applies to the speaker only).
4. No singing or dancing... most of the time.
5. Answer all questions, even if you have to make up the answer.
6. Do not raise or lower your voice suddenly. This could disturb those resting in the audience.
7. Make use of the accuracy/clarity duality. It is very easy to be both inaccurate and unclear at the same time.
8. No salacious physics jokes about two physicists and a religious person.
11. Make sure the viewgraphs are ordered correctly.
9. Prior to the talk, practice the art of ducking any flying vegetables.
10. Don't let boo's or hisses cause you to stray from your prepared talk.
12. Hand gestures to emphasize particular points can be used extensively, provided they do not insult any particular ethnic group.
13. Under no circumstances should you delete any overheads from your talk. Simply speak more rapidly and quickly flash all of the viewgraphs. [The world record for an APS meeting is 56 viewgraphs, 12 with substantial equations, given in only 10 minutes, at a spoken rate of 430 words per minute.]
14. Be sure to include this phrase on each overhead: "This talk could not possibly be supported by the U.S. Government, Industry, or any Educational Institution."
15. There is no need for a concluding overhead if you think you have said everything.
16. In the end, there are no rules.

From "*Learning from a Negative Example*," talk by Brian Schwartz, Brooklyn College, at the APS March Meeting in Los Angeles.

Forum on Industrial and Applied Physics
JOBS ENGINE
The American Physical Society
The American Physical Society is an organization of more than 40,000 physicists worldwide

The APS Forum on Industrial and Applied Physics (FIAP) has established an online jobs search engine to assist young physicists seeking job opportunities by serving as a contact point between them and potential employers. The CareerWeb Resumé Database is a searchable engine for both job seekers and potential employers; FIAP membership is not a prerequisite.

Physicists seeking employment opportunities can enter their resumés online using one of three options: (1) enter the resumé and keep it confidential so that it is not searchable by employers, so job seekers can forward their resumés only to employers offering positions of interest to them; (2) enter the resumé and make it searchable by potential employers; (3) enter your resume and make it searchable using an alias to maintain confidentiality. The latter two options also enable users to make changes in their resumés online.

The Web site also includes suggestions and comments from FIAP members who are also recruiting professionals. One physicist employed in the industrial research sector of a large textile manufacturer suggests supplying the following critical information when applying for jobs: career goals (e.g., moving out of research into manufacturing); work interests (e.g., theoretical, computational, experimental); work style (e.g., close management or great freedom, alone or in groups); and any information about communication and social skills. "My observation is that employers typically don't doubt the capability of candidates, but they worry about career fit: whether they work well with others, and understand our constraints," Says another FIAP member, "The better a candidate communicates career goals and interest in the jobs, the better chance that person has of succeeding." Such jobs almost always require cross-disciplinary skills, so any additional coursework in project management, business, manufacture design, etc., is helpful in terms of preparing graduate students for the realities of today's job market.

Employers and recruiters who are APS/FIAP members can post job descriptions on the site at no cost, or control which candidates contact them by simply searching the CareerWeb Resume database. Such posts include information about the hiring organization, the job opportunity and contact information. Potential employers who are not APS/FIAP members should contact Chris Bastian at cbastian@cweb.com for more information on establishing a presence on the site. APS members may access the FIAP Jobs Search Engine through the FIAP homepage [www.aps.org/FIAP/index.html].

AIP Resumé Posting Service

The AIP Career Services also operates a Resumé Posting Service for the APS and physics community. It is provided free of charge to physicists seeking employment. Resumés, identified by number only, are entered into a searchable database which is available to employers. The identity of the jobseeker and a complete resumé will be released to employers who contact our office directly. Participants will be notified of who requests your resumé. For more information, contact: Career Services Division, AIP, One Physics Ellipse, College Park, MD 20740-3843, Tel: 301/209-3190, Fax: 301/209-0841, E-mail: jkiene@aip.org. Both the FIAP Job Engine and the AIP posting services may also be accessed through the APS Home Page [www.aps.org under the Career/Employment button].

A Physical Sciences Internship opportunity web-site is now available at: www.aip.org/careers/intern/.

The APS Career and Professional Development Committee Receives Final Approval

One of the primary motivating factors shared by the members of the APS Task Force on Careers and Professional Development (*APS News*, June 1997) was a desire to devise workable long-term strategies to better prepare physicists for a multitude of careers options. The task force made a number of key recommendations. The first was that a separate APS committee be established to address career and professional development issues. This has now happened in the newly established Committee for Careers and Professional Development (CCPD). APS Council unanimously approved the bylaw change establishing the CCPD at its April 1998 meeting. John Lowell, Applied Materials Inc, is serving as the first Chair of the CCPD.

A second key recommendation was for the establishment of a mechanism so that any materials developed could be disseminated widely, particularly to faculty and students through physics departments in academic institutions. This recommendation led to the idea of establishing a Career and Professional Development Liaison (CPDL) Program (see front-page article for a description of the first workshop of the CPDL Program). In addition, the CCPD will monitor career/employment status from both the perspective of the employers and physicists, such as was done in the recent email survey of Junior members and statistical studies. In addition, the CCPD is investigating initiation of a career and professional development site visit program to physics departments; offering a series of short courses for professional development on such subjects as elements of patent law, accounting, proposal writing and others. In addition, the CCPD is working closely with APS Units and committees, such as FIAP and CSWP, AIP's career and statistical divisions and Corporate Associates, and the physics community. Members with comments or suggestions for the CCPD to consider are invited to contact John Lowell, Barrie Ripin (ripin@aps.org), or Arlene Modeste (modeste@aps.org).

CPDL Program Launched *(continued from page 1)*

dustry and academia. The afternoon presentations were concluded by Robert C. Hilborn of Amherst College, who discussed the differences between applying for jobs at research universities and applying for positions at teaching-intensive universities.

The final part of the workshop, led by Diandra Leslie-Pelecky, was a discussion of future activities for the CPDL program and APS's role in providing information, communication and resources. A number of suggestions were made by participants, including:

- Provide departments with accurate and timely career and employment information and statistics.
- Produce career-oriented materials such as CD-ROMs, presentations, etc. for faculty to customize and use for students.
- Put information on internships/externships on the web: where they are, and how students can participate.
- Establishing a CPDL website to provide information to CPDL participants. The workshop presentations will be made available to Liaisons as PowerPoint files so that participants can adapt the information in the presentations to their particular circumstances.
- Facilitate a threaded web-based discussion group to allow sharing of ideas, problems and solutions
- Plans a larger-scale CPDL meeting.

The APS is in the process of setting up a web-site and discussion group for the exclusive use of participating department Liaisons. Departments participating in the Liaison Program will receive priority in a compilation of a resource of best practices, eligibility for possible career site visits, and other physics career related information. The Workshop and the planned future activities of the CPDL program were met with overwhelmingly positive evaluations from participants. Departments interested in participating in the Liaison Program are invited to contact Barrie Ripin (ripin@aps.org).

Career Liaison Program Workshop Attendees

Amherst College
Applied Materials, Inc.
Argonne National Laboratory
Arizona State University
Brooklyn College/CUNY
California State University, Fullerton
California State University, Los Angeles
Case Western Reserve University
Florida State University
General Motors R&D Center
George Washington University
Harvard University (student reps)
Idaho State University
Kent State University
Lawrence Berkeley Laboratory
Louisiana State University
Massachusetts Institute of Technology
North Carolina State University
Oklahoma State University
Oregon State University
Rose-Hulman Institute of Technology
Syracuse University
Texas Technology University
The Ohio State University
University of Alabama
University of California, Davis
University of California, San Diego
University of Illinois, Urbana Champaign
University of Kentucky
University of Maine
University of Maryland, Baltimore County
University of Nebraska
University of Nevada, Reno
University of Pittsburgh
University of Southern California
University of Vermont
Utah State University
Wake Forest University
Worcester Polytechnic Institute

Plus several representatives from the APS and AIP.

Four Corners Section Holds First Meeting

The fledgling APS Four Corners Section held its first annual meeting at the University of New Mexico, April 3-4. The section represents the APS members residing in Arizona, Colorado, New Mexico and Utah. The meeting began with presentations of contributed papers on Friday afternoon, followed by a banquet, with keynote lectures by APS President Andy Sessler and Murray Gell-Mann of the Santa Fe Institute. Saturday's sessions included lectures on such topics as an update of current exciting research taking place at Los Alamos National Laboratory (John Browne), and Sandia National Laboratories (Thomas Picraux); physics research for next generation space systems at Air Force Research Laboratory (Janet Fender); and photovoltaic research and future directions at National Renewable Energy Laboratory (Satyen Debs).

Quantum Computing. There has been increased experimental interest in quantum computation since 1994, when it was shown that a quantum computer could efficiently factor large numbers and a scheme was proposed for realizing quantum logic gates with cold trapped ions. According to M.S. Gulley of Los Alamos National Laboratory, who spoke on Saturday morning, ions cooled to their motional ground state in a linear trap may be used as the individual qubits, and entangled states between these ions can be constructed using laser manipulation of the ions' states. [For more on quantum computing, see story, page 4]

Neutron Testing of ICs. The high-energy neutron source at the Los Alamos Neutron Science Center (LANSCE) produces beams of neutrons for accelerated testing of integrated circuit devices, according to LANL's S.A. Wender. Neutrons produced in the atmosphere by cosmic-rays are thought to be a significant threat to integrated circuits at both aircraft altitudes and lower elevations, causing single event upsets, multiple event upsets, latchup and burnout in semiconductor devices. Neutrons are produced at LANSCE via spallation reactions with the 800 MeV pulsed proton beam. Proton beam currents of about 2 microamperes strike a tungsten target and produce a spectrum of neutrons whose energy and intensity can be precisely measured by time-of-flight techniques. The neutron spectrum produced in this manner is very similar in shape to the atmospheric neutron spectrum at 40,000 ft, with intensities over 100,000 times greater than the cosmic-ray neutron flux at 40,000 ft (sea level).

Thin Film Charged Particle Detector. Current charged particle detectors such as silicon barrier detectors are unable to operate at high temperatures or in a high radiation background. However, Brian A. Roy of the Colorado School of Mines reported that it is possible to construct a new type of charged particle detector that does not suffer from these restrictions. This involves the stacking of several alternating conducting and insulating layers. It is then possible to estimate the number of charged particles that stop in any given conducting layer, and hence the particle energy by measuring the current from the layer. Detectors based on this design have been built and tested with promising results, and a new detector is currently under construction that would greatly reduce its size. The linear particle accelerator, located at the CSM, will used to evaluate this new design.

Laser Induced Breakdown Spectroscopy. Jon E. Sollid of Coyote Mining and Environmental Instruments described a new technique for in-situ analysis of mineral exploration samples, dubbed Laser Induced Breakdown Spectroscopy (LIBS). The technique can be used to provide exploration companies with precise and accurate chemical analysis in the field in real-time, resulting in major time and cost savings, according to Sollid. Using a field portable analyzer, anomalies can be followed up immediately while crews are still in the field. Lower limits of detection LLDs are element dependent, but many are sufficiently low to be useful in exploration. LIBS analysis require little or no sample preparation.

NMR Studies of Fluid Flow. A collaboration of researchers at New Mexico Resonance and the Lovelace Respiratory Research Institute are using nuclear magnetic resonance (NMR) to non-invasively measure fluid structure, flow, and diffusion. Parameters measured include not only concentration but also higher order variables of the position, such as velocity, velocity fluctuation, diffusion, and dispersion. NMR makes these measurements along directions defined by magnetic field gradients so anisotropies of parameters can be measured. When combined with imaging, traditional NMR can yield spatial dependence of heterogeneities of these anisotropies.

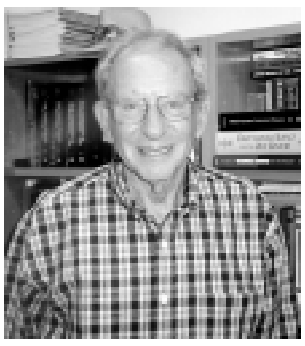
Four Corners Section Executive Committee attendees clockwise from left rear: Brenda Dingus (U. Utah), Andrea Palounek (LANL), Howard Voss (U. Arizona), Bill Evenson -Chair (Brigham Young U.), Mariet Hofstee (Colorado Sch.), Scott Nutter (Eastern NMU), Harry Lustig (Sante Fe), Judy Franz (APS Executive Officer), Michael Petras (Motorola), Eric Jones - Sec. Tres. (Sandia), and J.D. Garcia - Chair-Elect (U. Arizona). Not in photo: David Wolfe - Vice Chair (U. New Mexico), Barrett Ripin (APS).

Four of the students receiving awards ($100) for best presentations at the Four Corners Meeting. Student award winners are: Leslie Chavez (UNM undergraduate), Ronald Grazioso LANL, Chris Heil LANL (going to UNM in the fall as a grad student), Randy Jacobs LANL, J. D. Patterson (U of Colorado), Brian Roy (Colo School of Mines, undergraduate), Peter Schwindt (LANL, going to U of Colorado in the fall as a grad student), Morgan Wascko (LANL, UC-Riverside), Jason Webb (NM State), Marc Welliver (U of Colorado)

Triple Flames. The study of (subsonic) combustion is divided for simplicity into "premixed" and "nonpremixed" regimes. However, according to LANL's Sandip Ghosal, a more realistic situation is the partially premixed regime, where the composition of the mixture varies continuously from pure fuel to pure oxidizer, as in the example of a fuel jet in an oxidizing atmosphere. In some such situations a particular 2D flame structure, known as a "triple flame" or "tribrachial flame," is observed. It consists of a curved premixed branch followed by a trailing diffusion flame. Ghosal has developed an asymptotic theory for the structure and propagation speed of triple flames, which he has compared with numerical simulations. Triple flames are thought to play an essential role in turbulent combustion, and, an understanding of their behavior may be of importance in modeling combustion problems.

Science Education. During a Saturday morning session, D.M. Riffe of Utah State University described the curriculum-wide integration of Mathcad into USU's undergraduate physics program. The foundation is a one-credit computer-laboratory experience in which the students work through a Mathcad handbook that teaches the students to use Mathcad in the context of solving physics problems. By working through the handbook the students gain familiarity with the functions of Mathcad that are most useful for solving undergraduate physics problems. To date, Mathcad has been used in at least 10 upper-division physics courses at USU.

Merzbacher Appointed as Consultant for APS Centennial



Eugen Merzbacher

Former APS President Eugen Merzbacher, a professor of physics at the University of North Carolina, Chapel Hill, has been appointed as a senior consultant to the APS Centennial Office. Merzbacher will advise the Centennial staff on the the general APS exhibit; the individual unit exhibits and symposia; the various planned APS Reunions; the Centennial public relations initiative; and other issues as needed.

Born in Berlin, Merzbacher received his early education in Germany, but moved to Turkey in 1935 as a refugee from Nazi Germany. In Turkey, he completed his secondary and college-level education, and subsequently taught high school until 1947. He then became a graduate student in physics at Harvard University, receiving his PhD in 1950.

After one year as postdoctoral fellow at the Institute for Advanced Study in Princeton, and another year as a visiting faculty member at Duke University, Merzbacher joined the University of North Carolina at Chapel Hill in 1952. There he moved through the academic ranks and eventually became a Kenan Professor of Physics, serving for several years as chair of the Department of Physics and Astronomy. In 1988 he was elected as APS Vice-President, serving as the Society's President in 1990, and has also served on and chaired numerous APS committees. He is a member of the Editorial Board of *Physical Review A* and of *Atomic Data* and *Nuclear Data Tables.*

Merzbacher retired from teaching in 1991, and is now Kenan Professor of Physics, Emeritus. In 1993 UNC awarded him an Honorary Doctor of Science degree. His primary research interests have been in the theory of ion-atom collisions, beta decay, nuclear reactions, and the fundamentals of quantum mechanics. In 1961 he published the textbook *Quantum Mechanics*, which is now in its third edition. While at Chapel Hill, he was also instrumental in the creation of the Triangle Universities Nuclear Laboratory (TUNL). He served for more than three decades as principal investigator of the UNC-CH component of this three-university program, supported by the U.S. Department of Energy.

APS Northwest Section is Established

Northwest Section organizing group met in Seattle in February.

The formation of an APS Northwest Section is well underway following the APS Council's approval of its establishment at its April meeting. Principal organizers Ernest Henley (University of Washington) and Mary Alberg (Seattle University) met earlier this year with 12 other regional volunteers to draft a suitable charter and bylaws. Among the attributes they would like to see in the new section are joint activities with local chapters of the AAPT, as well as a local coalition of physics departments called the Pacific Northwest Association of Collegiate Physics. Close ties to Canadian members of both the APS and the Canadian Association of Physics are also desired, as well as the inclusion of local industry and government laboratories.

The first meeting of the fledgling section has tentatively been scheduled for Spring 1999, in Vancouver, British Columbia, with subsequent meeting sites rotating throughout the region. The interim officers elected to govern the unit until regular elections can be held are: Yogi Gupta (Washington State University), chair; Erich Vogt (University of British Columbia), chair-elect; and John Drumheller (Montana State University), vice-chair. Henley will serve as interim secretary-treasurer.

1998 March Meeting Highlights *(continued from page 3)*

will heat it up, while removing the magnetic field will cool it down and enable it to absorb heat from its surroundings. Not only is this process more efficient than conventional refrigeration (in which the compressing and expanding fluid refrigerants lose energy to processes like turbulence), it is more environmentally friendly: the solid Gd material can't leak out, and the only working fluid is water, which carries heat to the Gd refrigerant from the objects to be cooled. Carl Zimm of Astronautics Corporation in Wisconsin described a Gd-based magnetic refrigerator, built in collaboration with the Ames DOE Laboratory, that has efficiency rivaling that of a conventional unit and has been operating for more than a year. Other physicists at the same session discussed similar approaches. This potentially more efficient design can be used in supermarkets, which could conceivably lower the cost of groceries by using less energy-hungry refrigerators.

Ultrafast Laser Pulses. The interaction of matter with ultrafast and ultra-intense laser pulses is a current frontier of science. New discoveries often result from the ability to explore a new regime. Here one is exploring both extremely short time scales (below one ten-trillionth of a second) and extremely high intensities (above a trillion watts per square centimeter), according to Roland Allen of Texas A&M University, who spoke at a Wednesday morning session. The usual approximations of theoretical physics and chemistry break down under these conditions, and both electrons and atoms exhibit new kinds of behavior. In fullerenes, an ultrashort but less intense pulse can be used to "pluck" the molecule and start it vibrating.

It has already been observed that porovskites can undergo structural changes when exposed to electromagnetic radiation. In semiconductors like Si and GaAs, an ultrashort laser pulse can cause electrons to be quickly promoted from bonding states (in the valence band) to antibonding states (in the conduction band). The lattice is then destabilized, and the band gap collapses to yield a metal-like state. In current experiments, the material undergoes a nonthermal "melting", similar to the thermal melting observed in earlier experiments on longer time scales. Allen's simulations revealed that lattice destabilization occurs at about the same threshold intensity for Si and GaAs, in agreement with the experiments. The reason is that Si has tighter chemical bonding, being a smaller atom, but also has a higher population of excited electrons because of its narrower band gap.

Liquefied Particle Physics. One of the most complex processes known to physicists is the process of turbulence, in which a fluid exhibits irregular flow patterns that vary randomly in space and time. A Cornell group is applying particle physics detection technology to fluid mechanics, by installing a silicon-strip detector also used in Cornell's CLEO accelerator. The detector can make up to 100,000 measurements per second of a particle—and can track perhaps up to 6 particles at a time, promising insights into such questions as how two particles that are initially close together in an extremely turbulent fluid fly apart. Such studies may aid understanding of problems such as the transport of pollutants in the atmosphere.

Quick as a Flash: Femtosecond Lasers. New discoveries often happen at the frontiers of physics. Examples include the discovery of the top quark at Fermilab (the highest obtained particle collision energies) and Bose-Einstein condensates of gases inside magneto-optic traps (the lowest obtained temperatures). A relatively new frontier area is the domain of short-time (100 femtosecond), high-intensity (terrawatts/cm^2) bursts of laser light. Pulses generated by femtosecond lasers can almost instantly destabilize a semiconductor, turning it into something like a metal, at least temporarily. Papers presented at a Tuesday session considered what these pulses do in a variety of materials, including C-60 molecules (buckyballs), and human-vision (retinal) and photosynthesis complexes.

Polymer LECs. Alan Heeger of UC-Santa Barbara described a new type of light-emitting device based on a semiconducting polymer. In this design, known as a light-emitting electrochemical cell (LEC), researchers create a blend of a light-emitting polymer material and a solid electrolyte, a substance that transports ions. According to Heeger, polymer LECs have important advantages over polymer LEDs. For example, the way in which electrical charge is injected into the semiconducting polymer is the same for all LECs independent of the color of the emitted light, and the performance of LECs is insensitive to the thickness of the material.

Wavelet Analysis of Heartbeat Patterns. Scientists from Boston University's College of Engineering have developed the first objective diagnostic tool to determine whether a patient suffers from congestive heart failure. A simple mathematical analysis of the pattern of a person's heartbeat detects the problem with 100 percent accuracy. Using a standard data set, the scientists, led by Malvin C. Teich, obtained clinically significant results using this multiresolution wavelet analysis technique to determine how much the time duration of a collection of heartbeats fluctuated and determine whether or not a patient suffers from congestive heart failure.

Traditionally, congestive heart failure is diagnosed by a physician through visual observation, using indicators such as swelling in the patient's ankles and through stethoscopic observation of heart and lung sounds. Teich's technique uses objective criteria to make the diagnosis. "It is perfectly reasonable that using this information we could develop a simple, portable device that an individual would wear to monitor their heartbeat pattern and warn them of a developing problem," Teich said. "Now that we know that this technique can predict congestive heart failure, we will apply it to other cardiac disorders that are more difficult to diagnose."

The Noisy World of the Cell. For the physicist, noise is more than just annoying sounds - it is any type of random and unpredictable variability, especially at the molecular level. There are many types of noise that occur in biological cells. One of the most interesting is ion channel noise. Ion channels are tiny pores that can open or close and allow important substances, such as sodium, potassium, and chlorine in and out of the cell, and are the machinery behind many important cellular processes such as the firing of nerves. But how do random, noisy ion channels produce precise, organized activity? Answers to this fascinating question are just beginning to be revealed, according to Paul C. Gailey of Oak Ridge National Laboratory.

One surprise is that cells may be able to actually use noise to their benefit. For example, ion channel noise can provide just enough of a tickle to make certain nerves fire spontaneously. While too much noise would make for erratic activity, too little can result in no firing at all. The amount of noise in the cell depends in part on the number of ion channels in its membrane. Cells may exploit this fact and control the number of channels to produce optimum noise levels. Some studies indicate that noise can enhance the energy production of cells, amplify signals, and assist in transporting substances in and out of the cell. Others suggest that cells may utilize feedback processes to help suppress ion channel noise. "With characteristic creativity, nature appears to be using noise just as it would any other available resource, said Gailey.

Laser Medicine. If you have ever been the beneficiary of laser surgery, thank a physicist. Rangaswamy Srinivasan of UVTech Associates in New York showed at IBM in the early 1980s that ultrashort laser pulses could vaporize specific regions of biological material without damaging the surrounding material, helping to lead to the use of lasers in medicine. Honored at the APS Biological Physics Prize session, he described the physical explanations of how laser beams can safely remove tissue. The session also featured Michael Berns of UC-Irvine, who discussed how "laser scissors" and "optical tweezers" can now cut and paste chromosomes and sequence genes. Alexander Oraevsky of the University of Texas discussed how aiming laser light at skin lesions can induce sound waves that provide information on whether the lesion is benign or cancerous.

The Mysteries of Water. Essential for life on Earth and the beautiful geological features on the surface of our planet, water has many unusual properties which are not completely understood. For example, heating water shrinks it, unlike most other liquids. Three sessions at the meeting dealt with the physics and chemistry of water. Describing the latest quantum-mechanics based simulations of water, David Clary of University College in London was part of the team that recently discovered that water only begins to act like the liquid with which we are familiar when at least six molecules of H_20 are clustered together. Gene Stanley of Boston University discussed an hypothesis that predicts a previously unknown, low-temperature "critical point" for water in which two liquid phases—a higher-density liquid and a lower-density liquid—can coexist.

Making Nanopattern Surfaces. Researchers are pursuing an important new frontier in nanotechnology: to make nanometer-scale patterns of two or more chemically and physically distinct materials. Such nanopattern surfaces could be used as chemical and biological sensors or the "masks" that etch tiny circuit patterns in computer chips. Martin Moeller of Ulm University in Germany described a new technique for creating such surfaces. The technique involves embedding a metal or semiconducting nanoparticle inside a polymer whose interior acts as a "nanocompartment." Subsequently, these nanoparticle-containing polymers are deposited onto polymer films. Afterwards, the polymer shells can be removed with plasma beams similar to those used to etch patterns in computer chips. This leaves metal or semiconducting nanoparticles (1-20 nm in size, depending upon the amount of space in the nanocompartment) which can be separated by 10-200 nm (depending on the overall size of the polymer which embeds the nanoparticle).

Making Smooth Silicon Surfaces With Chemistry. The silicon-silicon dioxide interface in ultrasmall silicon-based transistors must be smooth on the atomic level or else their performance is degraded. If the boundary is too rough, electrons moving through the semiconducting silicon layer can scatter from the insulating SiO_2 boundary, increasing electrical resistance to undesirable levels. Melissa Hines of Cornell showed that an ammonium fluoride solution could etch away surface roughness on Si(111) and produce surfaces of near-atomic smoothness over a large area. Hines hopes to find similar chemical methods for the Si(100) surfaces used in integrated circuits.

Marcus Weldon of Lucent Technologies presented studies of how H_2O reacts with silicon at elevated temperatures during the beginning stages of forming a silicon dioxide layer. Marrying infrared spectroscopy and quantum chemistry calculations, Weldon and colleagues discovered for the first time a silicon "epoxide," a triangular arrangement of silicon-oxygen-silicon that apparently dominates the surface at the intermediate stages of these reactions. Controlling the quality of SiO_2 layers is increasingly important in state-of-the-art silicon devices; one recently fabricated SiO_2 layer has a thickness of just three SiO_2 molecular units in an ultrasmall silicon transistor announced by Lucent last year and envisioned for mass production by 2010. Built by Greg Timp and colleagues at Lucent, this 60-nm transistor is four times smaller, five times faster, and needs 60 to 160 times less power than present transistors.

Saving Energy in the 21st Century. The research of Mark Levine, director of the Environmental Energy Technologies Division at Lawrence Berkeley Laboratory, has led to enormous energy savings for a number of billion-dollar technologies, such as lighting and windows. He reported on new developments in duct sealants (energy waste in ducts can be as high as 30%); ultraviolet water purification; new incandescent lights; and a redesigned torchiere lamp. Still in the future is an energy-efficient fume hood to provide a safe working environment in laboratories and factories. Levine maintains that while immediate energy savings can be realized by switching to alternative fuels and requiring permits for carbon emissions, new technologies — as well as new materials, processes, and manufacturing methods — will be essential in the long run.

Beyond the Ivory Tower. A joint session of the APS Committee on the Status of Women in Physics and the Forum on Industrial and Applied Physics featured four prominent female physicists who have established successful careers outside of academia, who offered advice to physicists seeking nontraditional employment opportunities. Barbara Wilson (Jet Propulsion Laboratory) described her experiences working in a federally funded R&D center, outlining possible employment areas. Mary Young (Hughes Research Laboratories) focused on some of the key differences between an academic and industrial environment. Both she and Bell Labs' Cherry Murray cited numerous strategies to prepare graduate students for jobs in industry. And Barbara Jones of IBM's Almaden Research Center identified exciting research opportunities in the world of data storage.

Special thanks to Philip F. Schewe and Benjamin Stein of the American Institute of Physics' Public Information Office for contributing to the coverage of technical sessions in this issue.

Announcements

Call for Nominations for 1999 APS Prizes and Awards

Members are invited to nominate candidates to the respective committees charged with the privilege of recommending the recipients. A brief description of each prize and award is given in the March *APS News* issue, along with the addresses of the selection committee chairs to whom nominations should be sent. Please refer to the APS Membership Directory, pages xxi-xxxvi, for complete information regarding rules and eligibility requirements for individual prizes and awards or visit the Prize and Awards page on the APS web site at http://www.aps.org. Unless specified differently, the deadline for receipt of nominations is July 1, 1998.

Prizes:

Hans A. Bethe Prize
Herbert P. Broida Prize
Tom W. Bonner Prize in Nuclear Physics
Oliver W. Buckley Condensed Matter Physics Prize
Davisson-Germer Prize
Dannie Heineman Prize for Mathematical Physics
High Polymer Physics Prize
Irving Langmuir Prize
Julius E. Lilienfield Prize
James C. McGroddy Prize for New Materials
Lars Onsager Prize
George E. Pake Prize
W.K.H. Panofsky Prize
Earle K. Plyler Prize
Prize to a Faculty Member for Research in an Undergraduate Institution
I.I. Rabi Prize
Aneesur Rahman Prize
J.J. Sakurai Prize
Arthur L. Schawlow Prize in Laser Science
Robert R. Wilson Prize

Awards:

David Adler Lectureship Award
Apker Award (Deadline is June 15, 1998)
Edward A. Bouchet Award
Award for Outstanding Doctoral Thesis Research in Beam Physics
John H. Dillon Medal
Joseph A. Burton Forum Award
Joseph F. Keithley Award
Maria Goeppert-Mayer Award
Dissertation in Nuclear Physics Award
Shock Compression Award
Leo Szilard Award for Physics in the Public Interest
John Wheatley Award
Francis M. Pipkin Award
Nicholas Metropolis Award for Outstanding Thesis Work in Computational Physics
Dissertation in Nuclear Physics Award

NOMINATIONS FOR PRIZES AND AWARDS

The following prizes and awards will be bestowed at the Fluid Dynamics Division Meeting in 1999. A brief description of each prize and award is given below, along with the addresses of the selection committee chairs to whom nominations should be sent. Please refer to the new 1998-1999 Centennial APS Membership Directory, pages A19-A37, for complete information regarding rules and eligibility requirements for individual prizes and awards.

1999 FLUID DYNAMICS PRIZE

Sponsored by friends of the Division of Fluid Dynamics and the American Institute of Physics journal Physics of Fluids.

Purpose: To recognize and encouragAnnouncementse outstanding achievement in fluid dynamics research.

Nature: The prize consists of $5,000, a certificate citing the contributions made by the recipient, and a travel allowance to the meeting at which the prize is bestowed.

Send name of proposed candidate and supporting information before 1 September 1998 to:. Elaine S Oran (Chair), 3516Duff Dr., Falls Church, VA 22041; Phone (202) 767-2960; Fax 202 767 4798; Email ORAN@LCP.NRL.NAVY.MIL

1999 OTTO LAPORTE AWARD

Sponsored by the friends of Otto LaPorte and the APS Division of Fluid Dynamics.

Purpose: To recognize outstanding research accomplishments pertaining to the physics of fluids.

Nature: The award consists of $2,000, and a certificate citing the contributions made by the recipient.

Send name of proposed candidate and supporting information before1 September 1998 to: Israel J Wygnanski (Chair), School of Engineering, University of Tel Aviv, Tel Aviv 69978, ISRAEL; Fax 972-36429540; Email wygy@genius.tau.ac.il

Physical Review Focus

PR Focus, the fully electronic journal featuring physics highlights, is available FREE through the APS Home Page [www.aps.org] or directly at [publish.aps.org/FOCUS]. To receive one-paragraph introductions to *Focus* stories each week by e-mail send the following message to majordomo@aps.org: subscribe focus [Leave the subject line blank].

PhD 'Family-Tree' Contest

APS News is holding a special Centennial PhD or "equivalent" lineage contest, in which entrants are asked to trace their professional "family tree" — i.e., the production of doctoral level physicists by their thesis advisors — as far back as possible. Prizes will be awarded to those who can trace their PhD lineage back the farthest, who have the most "generations," most Nobel Laureates, and other categories to be determined by the selection panel. Winners will receive prizes, and the most impressive or interesting lineages will be published in a future issue of *APS News*. See page 3 of the March 1998 issue of *APS News* for more details.

Entries should be sent to: Editor, *APS News*, The American Physical Society, College Park, MD 20740 or via E-mail to: letters@aps.org.

Physicists do it with Uncertainty

Bumper Sticker & Tee-Shirt Slogan Contest

Got a catchy, physics-related slogan you've always wanted to see on a T-shirt, bumper sticker, or coffee mug? *APS News* challenges its readers for the best such slogans. For example, APS Associate Executive Officer, Barrie Ripin, who brought you the limerick contest a year ago, said he is certain that physicists can do bumper stickers "relatively well." Ooh! Submissions can be in the form of text and/or graphics. There will be a number of categories for winning, including most humorous, most clever, best graphic, best public image, loudest groan from the judges, etc.. Finalist and winning entries will appear in a future issue of *APS News*. The best will be used on T-shirts, bumper stickers, and other products that will be available for purchase at the APS Centennial Meeting in March 1999 in Atlanta, Georgia. The deadline for entries is June 30, 1998. Submissions should be sent to: *APS News* Editor, The American Physical Society, One Physics Ellipse, College Park, MD 20740; Fax 301-209-0865, E-mail: TEESHIRT@aps.org

The Naval Research Laboratory is Celebrating its 75th Anniversary

The Naval Research Laboratory is celebrating its Diamond Jubilee the week of June 15, 1998. A weeklong sequence of events will highlight the achievements of NRL's past and will peer into the future. NRL's achievements range from discovery and early development of radar to key developments in navigation technology that led to the Global Positioning System. These innovations, among others, have contributed to shaping the 20th century and have brought cutting edge technology to the US defense.

For more information about NRL's Diamond Jubilee, daily schedule of the celebration events, and information about tours, demonstrations and exhibits, see the NRL web site [www.nrl.navy.mil].

75 Years
NAVAL RESEARCH LABORATORY

CAUGHT IN THE WEB

Notable additions to the APS Web Server. The APS Web Server can be found at http://www.aps.org

APS News Online latest edition

APS Committees and Governance

- International Affairs page updated
- Women in Physics Colloquium Speakers List updated
- Minorities in Physics Colloquium Speakers List updated

Meetings

- Ohio Section Spring Meeting Program
- April 1998 Meeting Program
- Virtual Press Room for April Meeting
- DAMOP 1998 Meeting Program
- Meeting IDs page added

Units

- DAMOP, DCOMP, DMP, GMAG
- FIAP Executive Committee updated
- DPF page now on APS site

THE BACK PAGE

Keep Tenure: Fix the Problems

by Frank A. Franz

Let me begin with a statement of disclosure. I believe that a well-administered system of tenure is beneficial to a university, and to its constituents. I generally support AAUP (The American Association of University Professors) policies and procedures in these matters. I also think that some changes, at some places, almost certainly are necessary. My credentials in these matters are simply those of a expatriate physicist in Administration who has had experience and interest in tenure issues at faculty and campus administrative levels at several research universities.

We could spend many pages discussing why faculty tenure in a university is (or is not) a worthy institution. That's not my purpose here. It is appropriate, however, to provide some background by referring to a few phrases in the 1940 Statement of Principles on Academic Freedom and Tenure, endorsed by the AAUP and many professional societies:

On faculty and academic freedom: "…full freedom in research and the publication of the results… freedom in the classroom discussing their subject… When they speak or write as citizens, they should be free from institutional censorship or discipline…"

On economic security: "…a sufficient degree of economic security to make the profession attractive to men and women of ability…" and,

On tenure: "…After expiration of a probationary period, teachers or investigators should have permanent or continuous tenure, and **their service should be terminated only for adequate cause**…" (emphasis added).

The connections between tenure, academic freedom, and economic security have existed for many years, and are very strong. For most people, the strongest rationale for tenure is the maintenance of academic freedom for our faculty, and the concomitant freedom from coercion or persecution. Tenure, as defined above, provides a powerful buffer against arbitrary and capricious acts by administrators or, indeed, by fellow faculty members. The questions most often raised are does that protection come at too great a cost, and, if so, are there other ways to provide it?

Underlying stresses

It's important to recognize some underlying stresses and demands that perturb the system. Most of us will agree, I believe, that the creation of the American research university is one of the great achievements of the twentieth century, and that the research university generates extraordinary scientific, educational, economic, and social benefits. But:

How often have you heard the question, "Why aren't your full-time faculty teaching our kids?"

Workloads and efficiency of faculty are being questioned, regardless of the status of tenure.

The public understands teaching and undergraduate instruction, or thinks that it does: it places its emphasis there. Research is far more remote, more difficult to embrace.

Many citizens have a poor understanding of the function and value of a research university.

A growing use of part-time instructors can add to stress within the university (tenured vs. non-tenured vs. part-time). Is the definition of "the faculty" changing?

Finally, there is the question of evaluation and assessment – of what, by whom, and with what effect is it carried out? There tends to be a misleading image of faculty removed from scrutiny, evaluation, and "control."

Tenure often becomes a scapegoat in these more pervasive issues.

The most important issues at stake in considerations of tenure policies are, I believe, post-tenure review and the burden of proof; standards for the removal of tenure; locus of tenure; and what, exactly, is tenured.

Post-tenure review and the burden of proof

The concept of "post-tenure" review is one of the most controversial issues facing faculties and administrations today. Obscured, at times, is the crucial issue of who bears the burden of proof in tenure-related personnel matters.

In the process leading to the **award of tenure**, a faculty member typically presents his or her record of accomplishment in teaching, research, and service. A succession of intensive evaluations, recommendations, and judgments of that record, usually incorporating some degree of appraisal external to the university**,** then follows. Throughout the probationary period that culminates in this process, **the burden of proof is on the faculty member** to demonstrate his or her suitability for the award of tenure.

The granting of tenure, as we see from the quotation recalled earlier, confers a permanent appointment in which one's service can be terminated only for adequate cause. In considering the **dismissal** of a faculty member from a tenured appointment, therefore, **the burden of proof falls on the university.** This matter of the shifting of the burden of proof from the faculty member to the university once a person reaches tenured status is of fundamental importance in the protection of academic freedom, and is deeply enmeshed in the very fabric of the university.

A problem in many proposals for post-tenure review is that periodic reevaluation, recertification, or re-qualification of the faculty member usually is implied. That's usually taken to mean "re-tenuring," and, at the very least, represents a radical shifting of the burden of proof from the university back onto the faculty member. It's very suspect, and very threatening. Is one innocent until proven guilty, or guilty until proven innocent? At the same time, most observers would agree, I believe, that tenure should not bestow upon one a shield that provides immunity against assessment of one's performance and evaluation of one's contributions to the university.

Annual reviews offer a solution

A reasonable compromise is possible in these matters. Meaningful annual reviews can be mandated for *all* faculty. We already require such reviews for probationary faculty: why should tenured faculty be exempt? Indeed, many universities already follow such a policy, or something reasonably close to it. Possible outcomes of such reviews include recognition of successes, contributions, and deficiencies; determination of salary increases; possible redistribution of workload; and possible provision of developmental assistance.

A somewhat more controversial, but necessary, requirement is an understanding that a pattern of problems found in annual reviews should result in corrective action. Continued deficiencies, if substantial enough, should lead into a separate and distinct process in which more severe sanctions, including dismissal, are possible. It is imperative that any process leading to the imposition of substantial sanctions include participation and endorsement by peer faculty.

There is a crucial difference between the approach suggested here, and the more standard notion of post-tenure review. Here, the burden of proof that disciplinary action is required clearly remains with the university. Typical safeguards for the preservation of tenure remain. There, the burden of proof falls on the faculty member to show that he or she should be continued in a tenured appointment: the presumption of "permanent or continuous tenure" is gravely weakened.

Standards for the removal of tenure

One of the prevalent arguments against tenure is that it provides a sinecure for the unproductive. Present standards for the dismissal of a tenured faculty member usually require the demonstration of incompetence, dishonesty, neglect of duty, or financial exigency. But what should our response be to a continued, unmitigated pattern of severely inadequate performance? Inadequacy is not incompetence. It is a stretch, too, to consider inadequacy equivalent to neglect of duty.

If public confidence in the university is to be maintained, and if externally imposed mandates for more Draconian measures affecting all faculty members are to be avoided, confidence must exist that the university deals effectively with cases of inadequate performance. Progressive actions to address inadequate performance must be available, and should include the ultimate possibility of dismissal.

Other issues

A person's tenure is usually considered to be campus specific, but where, within the campus, does it actually reside? Does it apply to the department, program, college, or entire campus? If a university closes its Dental School, does it have an obligation to find positions for the affected tenured faculty in, say, departments of Physics and English? AAUP policies suggest a campus-wide locus for tenure, but actual policies around the country differ greatly.

I believe that tenure is granted most appropriately in a person's academic department, or discipline, where one's credentials for teaching and research have been proved. Granting of tenure throughout a college makes a more problematic commitment and assumption on the appropriateness of a person's qualifications for reassignment to other areas, should that be necessary at some later time. Granting of tenure in a unit smaller than a department can place a person at undue risk of program termination due to changing emphases among sub-disciplines.

To what extent, if any, is salary protected by tenure? This question is particularly important in units where a faculty member may be tenured, but may be expected (required) to earn a substantial portion of his or her salary from professional practice. What happens if the opportunity to earn that portion is unavailable? In a more general circumstance, can a university continue someone's tenured appointment, but reduce his or her salary sharply? Answers are often not clear and well defined in institutional policy. But they should be.

Finally, some universities, mine among them, have a long responded to special needs by making a limited number of appointments of research faculty or clinical faculty. Expected levels of performance correspond to those of regular faculty, but responsibilities are more narrowly focussed. These positions carry a high degree of professional recognition and respect; confer an intermediate degree of job security; but usually do not include the promise of tenure. Such appointments appear to work well as long as they are kept clearly distinct from regular faculty appointments in scope of expectations, and are kept limited in number.

A final thought

While various kinds of reform in American higher education are often proposed, and are often appropriate, our overall system of higher education remains the envy of the world. The institution of tenure is firmly and inextricably rooted in that system. Modifications, where necessary, can be made through cooperation between faculty, administrators, and governing boards. Any benefits believed obtainable through more radical actions are, I believe, far outweighed by wrenching and destructive costs.

This talk was based on an invited paper presentation at the 150th AAAS meeting.

Frank Franz is President of the University of Alabama in Huntsville. Previously, he served as Provost at West Virginia University, and the Dean of Faculties at Indiana University, Bloomington.

Editor's note: The APS has appointed a task force on the subject of tenure (see page 7). Readers are encouraged to send comments to: letters@aps.org.

The Back Page is intended as a forum to foster discussion on topics of interest to the scientific community. Opinions expressed are not necessarily those of the APS, its elected officers, or staff. APS News *welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org.*