APS NEWS

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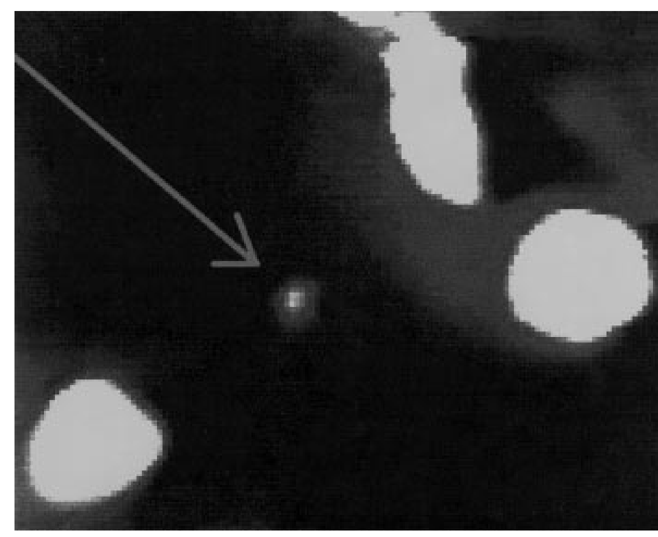
Highlights from Indianapolis: Trapped Francium, Energy Alternatives, Age of the Universe, Gender Gap

Approximately 1,400 physicists assembled in Indianapolis, Indiana, for the 1996 Joint Meeting of The American Physical Society (APS) and the American Association of Physics Teachers (AAPT), 2-5 May. The most varied of APS meetings because of the number of APS divisions represented in the program, the Spring Meeting explored current topics in particle physics, astrophysics, fluids, particle beams, physics of beams, nuclear physics, applications, and atomic, molecular and optical physics.

Topics of technical sessions included the first entrapment of a francium atom (see story below), new data on globular clusters (see page 4), the discovery of over 100 new isotopes, (see page 3), and recent advances in nuclear-based medical imaging (see page 2). General interest sessions included such topics as the future of renewable energy sources (see page 7), gender bias in the GREs (see page 3), and the future of physics. In addition, the AAPT organized several sessions devoted to issues in education, some in conjunction with APS committees or units.

Another prominent feature was a special plenary session on Friday afternoon, modeled on the Unity Day symposia held in recent years at the annual Joint APS/AAPT Meeting. The session featured the retiring presidential address by APS Past President C. Kumar N. Patel, as well as general lectures on black holes and Bose-Einstein condensation, respectively, by Kip Thorne (California Institute of Technology), recipient of the 1996 Lilienfeld Prize, and Carl Wieman (University of Colorado/JILA) (see page 5).

The traditional ceremonial banquet for the bestowal of prizes and awards was held Saturday evening, preceded by a reception hosted by APS President J. Robert Schrieffer (Florida State University). Twelve prizes and awards were presented, and the recipients gave lectures on their respective topics at various sessions throughout the week. Citations and brief biographies of the recipients appeared in the April 1996 issue of *APS News*.



Ten thousand Francium Atoms trapped in a volume about the size of a pin head.

Technical Sessions.
Neutrino Oscillations. Los Alamos scientists have found additional evidence that neutrinos have mass, observing 22 events that are consistent with muon antineutrinos oscillating into electron antineutrinos, compared to the nine events observed last year. Last year, an experiment at LANL turned

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Scientists Trap Rarest Element — Francium

Researchers at SUNY-Stony Brook have successfully trapped the world's rarest naturally occurring element, francium, setting the stage for high-precision tabletop measurements on how the weak nuclear force manifests itself at the atomic level. The Stony Brook team developed a technique to trap more than 10,000 francium atoms in a volume about the size of a head of a pin, using six laser beams and an inhomogeneous magnetic field.

Francium is the heaviest alkali and the least stable of the first 103 elements on the periodic table. Less than 30 grams of it exists on the Earth at any one time, in uranium deposits. It appears, atom by atom, as heavier atoms decay, and it disappears in less than 20 minutes as francium itself decays. While creating francium artificially has not been a problem, it has been a major challenge to trap francium atoms and study them. Researchers at Stony Brook, Berkeley, and elsewhere have previously used magneto-optic traps to collect radioactive atoms, but a challenge with francium has been to figure out how to tune the trapping lasers, since there are no known stable isotopes of francium to use as a reference. Recent developments were described by Gene Sprouse in a DNP Mini-symposia on Friday at the Joint APS/AAPT Meeting.

The SUNY team, headed by Luis Orozco, can now produce a million ions per second of francium-210, which has a half-life of about three minutes, by bombarding a gold target very close to melting point with beams of oxygen from the superconducting linear accelerator at Stony Brook. "You can't have a bottle of francium or a pellet of francium," said Orozco. "You have to be making it all the time in order to work with it."

Because the atoms were created with too much energy to be immediately trapped with lasers, the Stony Brook team devised methods to remove energy from them quickly and efficiently. After converting the ions into neutral atoms and slowing them down considerably, they send the francium into a magneto-optical trap, a device employing six laser beams — which had to be tuned to the correct frequency to slow and confine the atoms — and a nonuniform magnetic field. Inside the traps, the atoms bounce back and forth between specially coated glass walls, slowing down some atoms enough to be caught at the center of the trap.

Now that this rare element can be concentrated and confined, the research team plans to study the atomic properties of francium atoms, which opens new horizons for the understanding of the atomic structure of a very heavy element. For example, a new energy level has been observed for the first time, and lifetime measurements are in progress.

Studies of trapped francium can also ultimately lead to high-precision measurements of a phenomenon known as parity nonconservation, which would then provide information on the interrelationship between the electromagnetic and weak force. The francium energy transition is forbidden by the electromagnetic interaction because it violates parity, but is permitted by the parity-violating weak interaction. The effects of parity violation are at least 18 times more pronounced in francium than in cesium, another atom in which parity violation has been studied.

IN THIS ISSUE

APS E-print Server Running

The American Physical Society is developing a World-Wide-Web-based system for members and other physicists to post preprints, and to browse those which have been made publicly available. The service is similar to the 'e-print' archives run by Paul Ginsparg at Los Alamos since late 1991, but has some technical differences intended to make it more accessible and user-friendly, and other features that should help a larger fraction of the physics community get involved with this enabling technology.

The APS E-print service will also help in the exploration of new Internet-based technology for submitting, refereeing, editing and publishing papers in the *Physical Review* journals. A prototype version of the service will be available from July 1, 1996 through the APS home page [http://www.aps.org] under the 'New Services Available' listing for the journals, and during testing will be available directly at http://publish.aps.org/eprint/test/.

Physicists are invited to try the APS E-Print prototype and send comments to the administrators of the service at the e-mail address: eprint-adm@aps.org. Members can also contribute over the next few months to the setting of priorities for the service (such as what word processor formats to support) by answering the questionnaire available on the web at http://publish.aps.org/eprint/test/gateway/questions.

Technological Advances May Revolutionize Medical Imaging

New advances in medical imaging technologies could significantly revolutionize existing clinical practices by enabling non-invasive and low-radiation alternatives for diagnostic purposes, according to speakers at a Thursday afternoon session of the 1996 Joint APS/AAPT Meeting in Indianapolis, Indiana. Sponsored by the APS Division of Nuclear Physics and the Forum on Industrial and Applied Physics, the session explored such emerging technologies as the application of positron emission tomography to laboratory testing of animals, a functional mammography technique using radiotracer methods to detect breast cancers, and digital x-ray imaging with active-matrix, flat-panel imagers.

PETs for Imaging Laboratory Animals. Simon Cherry of the University of California, Los Angeles, described a positron emission tomography (PET) scanner that can detect features as small as 1.7 mm, compared to the four mm possible in conventional units.

In contrast to other medical imaging techniques, such as MRI or CAT scans, PET provides unique information on the rate of functional processes in the body. According to Cherry, one of its major strengths is the availability of positon-emitting isotopes of elements, such as carbon, nitrogen, oxygen, and fluorine. Many hundreds of compounds of these elements have been synthesized without changing their biochemical properties. By choosing the appropriate positon-emitting compound, PET can be used to measure biological processes such as blood flow, glucose metabolism, neutrotransmitter biochemistry, receptor affinity, enzyme activity, and gene expression.

However, while the process has been used clinically in the diagnosis and treatment planning of patients suffering from heart disease, cancer, epilepsy and Alzheimer's disease, its distribution to date has been limited to major research institutions and medical centers because of the high cost. There are currently fewer than 100 PET centers in the U.S. Many of these use the process as a biomedical research tool in animal studies.

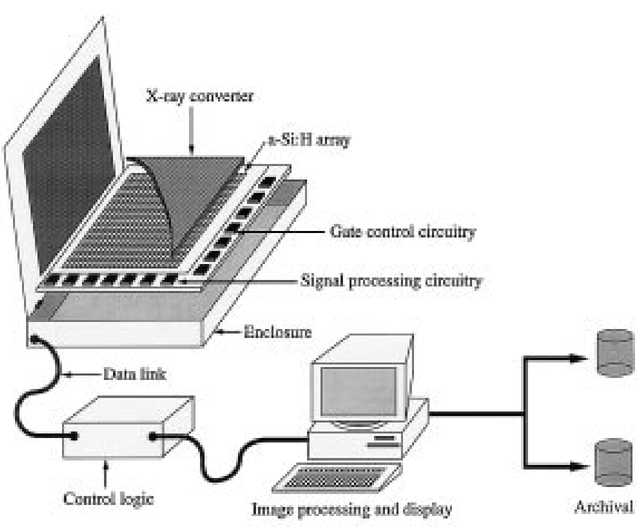
Cherry's laboratory, in conjunction with CTI PET Systems in Knoxville, Tennessee, are developing MICROPET, the world's highest resolution PET for the imaging of small laboratory images. "This development opens the possibility of performing animal drug trials without the need for vivisection, saving animal lives and cutting costs for drug companies," said Cherry.

A use of MICROPET is to look at the functional effects of substance abuse in the monkey brain and to relate this to human drug addiction and its treatment. Other potential applications include drug testing, the effects of cancer treatments, and developmental studies in the normal and abnormal brain.

Still other PET-based technologies under development include a low-cost PET system to fit inside a conventional MRI machine to permit simultaneous PET and MRI imaging, providing images of the anatomy and function in the same imaging session. Also in the works is a low-cost detector system for imaging the axillary nodes in patients with suspected breast cancer, often the first site where cancer spreads.

Functional Mammography. In efforts to fight breast cancer, physicians employ mammography techniques — such as ultrasound imaging, magnetic resonance imaging, PET, and single-photon imaging with a gamma camera.

In efforts to improve detection of breast cancers, Irving Weinberg of PEM Technologies in Bethesda, Maryland described a complementary approach called functional mammography, a procedure that provides information on the biochemical processes in the breast by introducing radioactive tracers into the breast via the bloodstream. The tracers are then are imaged with a detector similar to those used in PET scans.



Schematic of active-matrix imager system.

The detector system can be added to traditional x-ray mammography machines as a low-cost add-on, anticipated to be under $50,000. Unlike the gamma and PET cameras employed, which imaged areas of the body, functional mammography uses a detector system designed specifically to be placed on the breast, resulting in highly efficient signal detection. Weinberg hopes that this higher efficiency can be used to find smaller tumors, or reduce the patient radiation dose used in conventional nuclear medicine instruments.

Active-Matrix, Flat-Panel Imagers. Larry Antonuk of the University of Michigan in Ann Arbor described a pair of flat- panel imaging systems for diagnostic x-ray and cancer therapy imaging with image quality comparable to that possible through conventional techniques. Developed in collaboration between the University of Michigan and Xerox, these devices are capable of forming high-quality x-ray images in real time — as fast as 30 times per second.

As large as 26 centimeters on a side and a millimeter thick, the imaging circuits consist of thin-film transistors (TFTs) and photosensors made of amorphous silicon. Together these constitute an imaging pixel, with the TFT acting as a switch to control read-out of signal generated in the photodiode. The array is covered by a phosphorescent material which serves to convert incident X rays to light.

According to Antonuk, flat-panel imagers offer a number of advantages. They are inherently resistant against radiation damage, so performance will not degrade in the high radiation environment of cancer therapy applications. Good x-ray sensitivity, low noise and large dynamic range offer the potential of superior image quality at reduced exposure to the patient. Finally, digital images allow quick processing on a computer or shared electronically. Other advantages include the compact, thin profile of the imagers, real-time acquisition and display, and a high linearity of response.

"There is every indication that the future imaging performance of optimized active-matrix, flat-panel imagers could meet or exceed that of existing radiographic, fluoroscopic, and portal imaging systems," said Antonuk.

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Two New APS Topical Groups

At its Joint APS/AAPT Meeting, the APS Council and Executive Board approved the establishment of two new topical groups: the Topical Group on Magnetism and its Applications, and the Topical Group on Statistical and Nonlinear Physics. This brings the number of APS topical groups to seven. At least 200 APS members must petition Council to establish a new topical group, and the statement of areas of interest must be reviewed by each existing division and topical group to avoid excessive overlap.

The objective of the Topical Group on Magnetism and its Applications is to serve physicists working in magnetism, by providing a focal point for consideration of the technological aspects of magnetism within the APS; by organizing conference sessions of interest to physicists working in applications of magnetism; and by fostering interactions and meetings with other scientists and engineers interested in advancing and diffusing knowledge of the multidisciplinary field of magnetism.

The objective of the Topical Group on Statistical and Nonlinear Physics is the advancement and diffusion of knowledge in the interdisciplinary area of nonequilibrium statistical physics, with emphasis on spatially extended nonlinear systems. The group is also intended to encourage research and applications in this area and promote international cooperation.

Members wishing to join these new topical groups should write in the group in the space provided on their membership renewal invoice mailed in late May, and include $6 for each unit joined. For those members who have already sent back their invoice, they can send payment to APS: by mail with check or credit card; from the APS home page secure server with credit card; and by telephoning their credit card information. All related calls and correspondence should be directed to the APS Membership Department, One Physics Ellipse, College Park, MD, 20740-3844; phone: (301)209-3280.

Fighting the Gender Gap:

Standardized Tests Are Poor Indicators of Ability in Physics

Women and underrepresented minorities typically score significantly lower than men on the standardized tests designed to predict performance in undergraduate and graduate physics and math courses, and are hence more likely to be disqualified during the initial admissions screening process. But according to speakers at a Friday afternoon session at the 1996 Joint APS/AAPT Meeting, standardized tests such as the SAT and GRE are in reality very poor indicators of students' success in these rigorous subject areas.

Anne Marie Zolandz, who works on test development for the Educational Testing Service (ETS), reported that in 1994-1995, women represented about 28 percent of the total population for the SAT II physics test. However, while more women are taking the test than ever before, their scores continue to show a 50-point difference from the men taking the test. African-Americans, Hispanics, and Native Americans also score consistently lower than white and Asian-American students. Fewer students take the GRE physics subject test, with women comprising only 16 percent of the sample, and a comparison of scores of men and women reveal a standard deviation of about 150. The GREs are primarily taken by white students, followed by Asian-Americans, and these groups typically score significantly higher than other minorities.

The gender gap that favors boys persists across all other demographic characteristics, including family income, parental education, grade point average, course work, and class rank, according to Pamela Zappardino, a professional psychologist and executive director of FairTest, a Cambridge, Massachusetts organization that focuses solely on assessment reform, while working against misuses and abuses of standardized testing. "I think there's a fallacy in the assumption that the SAT or GRE is actually telling us something," said Zappardino. "At best, the SAT only accounts for about 16 percent of the variance in first-year college grades. That isn't a great predictor, by anybody's yardstick." The SAT math test, for example, consistently underpredicts women's performance in college math courses.

An April 1995 study at the University of California, Berkeley, found that women with identical academic indexes to men obtained higher grade point averages in every major on campus, including math and physical sciences. The report concluded that women should have about 140 points added to their index to compensate for the SAT's underprediction, and that non-test criteria, such as high school GPA, were much better predictors for women in all academically rigorous and male-dominated fields. David Morin, a physics graduate student at Harvard, conducted his own study last year of the correlation between GRE scores and performance in graduate school, focusing on Harvard students. He found that while there was a very slight correlation between GRE scores and graduate course grades, there was no correlation with other measures of success in graduate school, including oral exam scores and overall completion time for the Ph.D. degree.

The gaps in scores do not seem to arise from inherent gender or ethnic bias in the test itself. ETS has implemented numerous procedures in both test development and analysis to ensure the fairness of its tests. Specifically, it aims for broad representation on the test development committees, culling members from college and high school, public and private institutions, with geographic distribution and at least one minority and female representative. All tests are subject to "sensitivity reviews" to eliminate any potentially offensive language or content, and are checked for sufficient references to minorities and women when the subject matter warrants it.

Statistical analysis is also performed to identify test items for which subgroups of the population may perform differently. For example, on biology tests, it was discovered that women generally performed better on questions concerning the reproductive system. ETS uses a method called differential item function (DIF) to identify potentially biased items. Those which show a large differential factor of 15 percent or more are reviewed and sometimes discarded. Surprisingly, some of those items with a high DIF are standard physics problems in kinematics, electrostatics, or optics, with no obvious pattern in terms of content or skill levels to explain the wide differentials.

So where does the problem lie? A joint study by the ETS and the College Board concluded that multiple choice formats favor men over women, partly because men are more willing to guess on tests when they don't know the answer. Men also perform better on timed tests. Another ETS study found that when the time limit was removed from SAT subtests, girls' scores improved markedly, while boys' scores changed very little. At present, there are no plans to alter the format of the tests. "The ETS is dedicated to developing tests that are as equitable as possible to all groups," explained Zolandz. "But we are operating under the strengths associated with administering large-scale tests at a reasonable cost, which presently means multiple choice questions."

According to Zappardino, gender differences can certainly be manipulated by selected different test items. For example, for the first several years when the SAT was offered, boys scored higher than girls on the math section, while girls achieved higher scores on the verbal section. The ETS decided the verbal test needed to be balanced more in favor of boys, and added more questions pertaining to politics, business and sports. No similar efforts were made to balance the math section. "Since then, boys have outscored girls on both the math and verbal sections," said Zappardino. "So when girls show a superior performance, balancing is required; when boys show the superior performance, no adjustment is necessary."

Foreign students, especially those from China, also do well on the GRE subject test, although their performance in graduate school isn't any better or worse than their American colleagues. "That suggests to me that the physics subject test measures some specific skill that can be taught, and it is taught very effectively in China, but it is not at all clear how much this skill has to do with what we want to know about potential physics students," said Howard Georgi, who has been involved with graduate admissions at Harvard University for more than 20 years. Jennifer Siders, a recent physics Ph.D. from the University of Texas who is now at Los Alamos National Laboratory, took the GRE subject test four times to meet her department's minimum requirement of 700. She finally managed to raise her score 200 points, not by learning more physics, but by learning how to take standardized tests, often at the expense of her actual coursework.

The standardized test format also seems to favor students Georgi describes as "idiot savants": those with strong mathematical skills who are very good at manipulating symbols without learning any of the real physics behind them, but who nevertheless tend to perform exceptionally well on the GREs. In contrast, two of his most impressive undergraduate physics students, both women with excellent undergraduate records, scored much lower than expected. Phyllis Rossiter, author of *The SAT Gender Gap*, concluded that, "This highly speeded test rewards the facile test taker, rather than the sophisticated, thoughtful thinker who gathers new information, organizes and evaluates and expresses original thoughts clearly and concisely."

The impact of gender gaps in standardized test scores can be devastating. Female students are twice as likely as males to be disqualified by minimum cutoff score requirements, even though their overall academic performance tends to be higher. Many talented women and minority students may be discouraged from applying to top institutions if they feel their scores are too low. In addition to lower self-confidence and career expectations, the gender gap may decrease women's chances of earning fellowships.

Zolandz emphasized that ETS policy dictates that test scores should never be the sole basis for an admissions decision or rejection, and also discourages the use of cut-off scores below which applicants are summarily rejected. "The test scores are only one piece of information about a student,"

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Over 100 New Isotopes Discovered with Novel Fission Method

Scientists have produced over 100 new neutron-rich isotopes for elements between vanadium and rubidium at the GSI laboratory in Darmstadt, Germany, using a novel technique reported by Monique Bernas of the Institut de Physique in Grenoble, France, Friday afternoon at the Joint APS/AAPT Meeting. Unlike conventional target-fission techniques, in which a target of metallic foil is hit by a beam of light particles, Bernas has developed a new method that relies on projectile fission.

The new isotopes were made by accelerating uranium-238 up to an energy of 750 MeV per nucleon and colliding them with beryllium and lead targets. The fragments are then separated using the high-performance spectrometer FRS at GSI-Darmstadt. "All these neutron-rich isotopes are produced daily in nuclear power reactors, but they occur so rarely that they could not have been observed before," said Bernas. "This is the first direct observation of every single type of isotope produced in fission."

Fission is the most efficient means of producing neutron-rich isotopes, and since its discovery in 1938, more than 400 new radioactive isotopes have been found and studied, separated mainly by radiochemical methods. When the first uranium beam was accelerated at relativistic energies at the Lawrence Berkeley Laboratory, the fission cross-sections were measured in a pioneering experiment using small silicon detectors. However, while elements could be identified, the isotopes were not separated. On-line mass separation techniques were established in 1967, but the process was still chemistry-dependent and inefficient for some elements with short-lived isotopes.

Finally, in-flight separation techniques based on large spectrometers combining electric and magnetic fields were developed to separate ionized fission fragments independent from their chemical properties. They are fast, with the ability to identify fragments in a millionth of a second. However, only one in a million of the fission products are transmitted through the magnet. According to Bernas, the efficiency of her projectile-fission method is more than four orders of magnitude greater than that of former in-flight methods, and the time required for separation and identification is shorter than any beta-decay half-lives.

In the present experiment, rare fragments of all elements produced in fission are unambiguously identified event by event by measuring energy loss after separation by the spectrometer and time-of-flight along a well-defined path in the magnets. This is because the fragments move at nearly the beam velocity, close to the uranium beam direction, and are totally ionized, making them easier to detect than in previous experiments, where they emerged at low velocities in any direction with different ionic states. Using this technique, a large number of isotopes can be simultaneously observed; with target fission, only light elements have been identified in flight.

The new isotopes do not last very long; their expected half lives range between 20 to 700 milliseconds. However, a number of them qualify as "r-process" nuclei. According to Bernas, in our universe, about half of the abundance of elements heavier than iron was produced by rapid neutron-capture reactions occurring on a short time scale, and sequential captures therefore lead to the production of extremely neutron-rich isotopes. Later, these isotopes beta-decay back to the stable atomic nuclei.

Thus, the projectile-fission method opens a wide field for nuclear structure investigations. For example, the spectroscopic analysis of the newly observed isotope of nickel-78 — a doubly magic nucleus with 28 protons and 50 neutrons — will provide a crucial test for nuclear structure models, and will be used to determine residual interactions in the shell model picture. "Fundamental characteristics need to be known for these nuclei in order to understand mass abundancy in the solar system and to constrain astrophysical models for supernova explosions," said Bernas of the effect.

Particle Beam Processing Industrial Applications

There is burgeoning interest in the development of particle beam processing techniques for commercial applications, according to Fred Dylla of CEBAF, who opened a Friday morning session on the topic at the 1996 Joint APS/AAPT Meeting. There is increasing consumer and regulatory pressure to develop "greener" products using "dry chemistry" with reduced environmental impact, as well as production processes that yield only product and no waste. These objectives can be achieved with the use of photons or elementary particles in such commercial processes as surface modification, polymerization of materials, micromachining, and deposition and etching of materials, to name a few.

However, apart from a handful of high value-added applications, the commercial impact of these emerging technologies is limited because the unit cost is too high, and production capacity too low, to compete with existing chemistry-based methods. "Accelerated particle beams offer many diverse opportunities to process materials if economic targets can be met," said Dylla.

Electron Beam Processing. "The commercialization of electron processing applications is driven by demonstrated technical advantages over current practice," said Joseph McKeown of AECL Accelerators. "Mature and reliable accelerator technology has permitted more consistent product quality and the development of new processes. However, the barriers to commercial adoption are often not amenable to solution within the laboratory alone." Plant engineering, production, project management, financing, regulatory control, product throughput, and plant operational efficiency all contribute to the business risk. McKeown reported on his company's efforts to develop and market three IMPELA electron accelerators (10 MeV, 50kW) to commercial environments. The accelerators cost about $8 million each, and are designed to displace expensive chemicals used in the pulp and paper industry, to sterilize sewage sludge, detoxify chemically contaminated soils, to irradiate foodstuffs such as cellulose, and build radiation service centers for a diversity of other applications. Trials on 200 tons produced by paper mills in 1995 resulted in savings of $55 million and a 33% reduction in pollution. But competition from traditional chemical methods is stiff, and the investment capital required is considerable. McKeown estimated that about $1.5 million in revenue is needed annually to support outlays of this scale.

Electron Beam Curing. Victoria Weinberg of Northrup Grumman described progress in electron beam curing of metals used in construction of military and commercial aircraft, automobiles, and recreational equipment, such as tennis rackets and golf clubs. Despite the high capital and operation costs of conventional thermal curing methods, manufacturers in the past were willing to pay those higher prices to achieve optimal performance. Now, however, economic pressures are causing them to explore more cost-effective alternatives while maintaining high performance, the most promising of which is electron beam curing.

Electron beam curing uses high-energy radiation to effect physical and chemical changes in materials, and the process is 10 to 1000 times faster than conventional thermal curing, which usually takes 12-14 hours. Thermal curing requires cumbersome tooling and equipment. The autoclaves used in the process run about $3 million apiece, whereas an electron beam accelerator like the IMPELA can achieve the same production yields as four or five autoclaves, provided the volumes are high enough. Electron beam curing also has lower energy costs, reduced environmental costs due to lower toxic emissions and the use of solvent-free resins, and lower residual distress to parts. In addition, it allows manufacturers to vary the dosage to do selective curing.

UV FEL Processing. According to Michael Kelley, a senior research associate with DuPont Central Science & Engineering, the ability of ultraviolet light to transform materials was recognized at the turn on this century, and ever since, its use for processing has been re-investigated each time a new UV light source technology has become available. Particularly promising are results in the surface modification of metals and polymers, and in micromachining, using short, intense, single-wavelength pulses from excimer lasers. However, the cost of excimer laser light and their maximum unit size have limited their commercialization to high-value applications, mostly in medicine and electronics manufacturing. Also, the bulbs are too small for mass production quantities.

Kelley estimates that the horizon for commercialization is an energy cost below 0.5 cents per kilojoule of light, with a unit capacity above 10 kW. The only technology capable of reaching this goal is the free electron laser (FEL) based on a superconducting radiofrequency accelerator. The FEL's picosecond pulse length and high peak power offer further advantages for micromachining, and progress is being made toward a 1 kW technology demonstration, the minimum required for micromaching applications; surface processing requires about 10 kW.

Crystallography. According to C. Abad-Zapatero of Abbot Laboratories in Illinois, the unraveling of the three-dimensional structure of nucleic acids and proteins by physics-based experimental techniques — including x-ray diffraction from single crystals — has had a tremendous impact on our understanding of many biomedical processes. This structural knowledge is finding applications of macromolecular crystallography in biotechnology. For example, the knowledge of the three-dimensional structure of the target enzymes, complexed with their inhibitors, is helping to accelerate the design of future drugs.

Novel enzymes with new characteristics and improved catalytic properties are being produced by random and site-directed mutagenesis, and understanding these structural alterations in the mutant enzymes is facilitating the design of novel proteins with still unknown properties. In addition, the advent of the third generation synchrotron radiation sources such as the Advanced Proton Source (APS) has opened yet another avenue for the interaction between the physical and biomedical sciences. Abad-Zapatero believes that the wide availability of high brilliance, easily tunable x-ray sources will have a tremendous impact on the biotechnology of the future.

Other particle beam processing techniques described in the session included x-ray lithography, ion beam surface treatment, magnetically nozzled plasma accelerators for materials surface treatments, and high-power proton beam applications for such objectives as acclerator production of tritium.

APS Council Approves Three Statements on Energy Issues

The APS Council approved three statements on energy-related issues at its meeting in May. The first statement expressed concern over proposed large budget cuts for the DOE's Office of Energy Research for FY 1998 and beyond. The second urged sustained support for plasma and fusion science, which is faced a one-third cut in its budget for FY 1996. The third statement called for continued and diversified investments in energy research and development, and policies. The complete text of the three statements follows.

COUNCIL STATEMENT ON THE OFFICE OF ENERGY RESEARCH

The Council of The American Physical Society is gravely concerned that some policy documents and budget scenarios for FY 1998 and beyond plan large cuts to the DOE's Office of Energy Research, one of the primary sponsors of science in the United States. The cuts being considered would seriously damage a major component of the nation's outstanding basic research activities, in universities as well as national laboratories. They would threaten our nation's quality of life, future economic competitiveness and military security. The Council urges planners to rectify this situation and make budgetary adjustments accordingly.

For more than half a century, every Congress and every President has recognized the unique role of science in sustaining the nation's world-power status. They have consistently given federal investment in basic research strong bipartisan backing. In spite of extraordinary budgetary pressures, leaders in both political parties continue to maintain this bipartisan commitment. They have properly identified the National Science Foundation (NSF) and the National Institutes of Health (NIH) as key sponsors of scientific research. However, they have overlooked the prominent roles played by some programs in the mission agencies. This is now particularly true of the Office of Energy Research (OER).

More generally, among federal agencies, the DOE through OER is the leading supporter of basic research in the physical sciences, accounting for almost as much federal spending as NASA, the Department of Defense and the NSF, combined. In support of basic research as a whole, the DOE ranks third among federal agencies. With its progenitors, the Atomic Energy Commission and the Energy Research and Development Administration, DOE-funded research has led to more than sixty Nobel prizes, attesting to the high quality and impact of the work it supports.

The science base built through OER support over the past several decades has generated a wealth of technological advances that have dramatically improved the energy security of our nation. Research supported by OER has also made major contributions to magnetic resonance imaging (MRI) and medical isotopes; composite materials used in military hardware and motor vehicles; and x-ray diagnostics of computer chips and other high-tech materials. The OER has provided a vital complement to the support of basic research carried out by NSF and NIH and programs in other mission agencies. The OER, for example, as part of its radiation health and safety mission, initiated the human genome project and currently provides approximately one-third of all of its federal funding.

The Council of The American Physical Society strongly urges policy planners not to make short-term decisions which reduce DOE's crucial basic research activities. Proposed cuts would diminish our quality of life and our nation's future economic competitiveness and military security.

COUNCIL STATEMENT ON PLASMA PHYSICS AND FUSION SCIENCE

The American Physical Society stresses the scientific importance of plasma physics and fusion research, and the need for a research environment that encourages fundamental, long-term investigation. The one-third reduction in support of programs in plasma and fusion research in FY 1996 endangers this area of scientific research. Further cuts to these programs would seriously damage this important field. Once dismantled, these research programs may take decades to rebuild. The Council of the American Physical Society urges sustained support for plasma and fusion science by the U.S. government.

COUNCIL STATEMENT ON "ENERGY: THE FORGOTTEN CRISIS"

Our nation's complacency about the energy problem is dangerous. While the understandable result of currently abundant supplies of energy at low prices, such complacency is short-sighted and risky. Low-cost oil resources outside the Persian Gulf region are rapidly being depleted, increasing the likelihood of sudden disruptions in supply. Energy-related urban air pollution has become a world-wide threat to human health. Atmospheric concentrations of carbon dioxide, other greenhouse gases and aerosols are climbing; this will cause changes in temperature, precipitation, sea level, and weather patterns that may damage both human and natural systems.

The introduction of non-fossil-fuel energy sources, new ways of producing and using fossil fuels, and a myriad of energy-efficient technologies have helped to improve our energy security and to reduce environmental stress. In an era of growing global energy demand, such innovations must continue.

The Council of the American Physical Society urges continued and diversified investments in energy research and development, as well as policies that promote efficiency and innovation throughout the energy system. Such investments and policies are essential to ensure an adequate range of options in the decades ahead. Our national security, our environmental well-being, and our standard of living are at stake.

Science Policy, Black Holes and BEC Featured at Plenary Session

APS Past President C. Kumar N. Patel of the University of California, Los Angeles, delivered the annual retiring presidential address at a special general plenary session at the Joint APS/AAPT Meeting in Indianapolis, Indiana. Patel focused on the need to reinvent the relationship between physics and society, based on the significant changes that have occurred in the last five years.

The most crucial issue facing physics today is the changing expectations of society, which is asking questions about the cost-effectiveness of basic research in light of the continued worldwide economic downturn and worsening social problems, such as education, jobs, housing and physical safety of citizens living in inner urban areas. Specifically, international economic competition has now replaced the national defense security as a primary reason for supporting physics research, and there is an increased emphasis on conversion of basic research into new markets. "There is a perception that the U.S. is continuing to lose its competitive edge in high technology products worldwide, even when physics and physical science research is well supported," said Patel.

At the same time, universities are expected to interact more extensively with industry, which impacts the education and training of new physics Ph.Ds. "The efforts necessary to pursue careers in physics are seen as being out of line with the financial rewards of such careers," said Patel, citing visible unemployment of physicists as an example. "No discipline can expect to remain vibrant and capable of making advances if the smartest among the young people lose faith in its value."

Patel offered several suggestions to help physics and physicists prosper in the 21st century, including the continued expansion of understanding physical phenomena and the world; participation in setting priorities within physics and among related disciplines; learning to relate today's industrial and health science successes to the long-term investment of resources in physics funding; and improving technology transfer with improved partnerships between academia and industry. Physics research in the 21st century should also emphasize team efforts, cost effectiveness, productivity improvement, accountability, customer focus, multidisciplinary topics, training of physicists to be problem solvers, and integration into the social fabric.

"Physics will have to make its case based on its importance to understanding nature and natural phenomena and its utility to long- as well as short-term needs of the society," said Patel, adding that while the latter does not imply that basic research should be disregarded, "Physicists must be mindful of what constitutes value to society. If we forget the value aspect, then physics may well be funded at the same level as arts and humanities, which would not be acceptable to anyone."

The plenary session also featured a lecture by the 1996 APS Lilienfeld Prize recipient, Kip Thorne of the California Institute of Technology, who summarized the theoretical exploration of nonlinear phenomena in general relativity from 1960 to 1999, including work on black holes, singularities and gravitational wave detectors. For instance, the Interferometric Network presently under construction can perform observational studies of nonlinear space-time warpage and black holes, which have yet to be directly observed. After 2000, he believes detailed observational studies using gravitational wave detectors, as well as the Laser Interferometer Space Antenna (LISA) under development by the European Space Agency and scheduled for completion in 2014, will dominate this area.

Finally, Carl Wieman of JILA/University of Colorado gave a general lecture on last year's achievement of Bose-Einstein condensation (BEC), a new state of matter predicted over 70 years ago by Albert Einstein and the Indian physicist Satyendra Nath Bose. In this state of matter, gas atoms are cooled to near-absolute-zero temperatures and are crowded together to the point that the atoms overlap with each other and collapse into a single quantum state, where they behave essentially as a single "super-particle." Wieman's team combined two key technologies to make their Bose-Einstein condensates: laser trapping and cooling, and magnetic trapping and evaporative cooling.

Further studies of BECs promise important insights into the strange world of quantum mechanics, including nondestructible probes, phase transition dynamics, Josephson tunneling, and the shape and correlation of wave function, among other phenomena. They will also illuminate the future possibility of technologically useful inventions such as the hypothesized "atom laser," a potentially powerful nanotechnological tool in which the BEC atoms, all in the same energy state, would be deposited on surfaces with exquisite precision.

New Cluster Data Puts Universe at 13 Billion Years

One of the outstanding issues in astrophysics is determining the age of the universe. Some measurements of the Hubble constant suggest an age as low as 8 billion years, while studies of the very old stars in globular clusters indicate an age of 13 billion years or more. At a Thursday morning session at the 1996 Joint APS/AAPT Meeting, Don Vandenberg of the University of Victoria reported on measurements of globular star clusters that support previous estimates of their age to be at least 13 billion years. Based on measurements of the distances to galaxies in the Virgo cluster and elsewhere, the new data has important implications for the ongoing debate over the large-distance scale of the universe.

An important adjunct to the debate is the notion that the universe cannot be older than its older stars, which appear to be those in globular clusters, spherical clumps of hundreds of thousands or millions of stars found near and around our galaxy. VandenBerg uses the Canada-France-Hawaii telescope to view the ancient, metal-poor stars in globular clusters, which largely lack the elements heavier than helium that many younger stars inherit from earlier supernova explosions. By plotting the stars' luminosities versus their colors, and by employing the standard model for stellar evolution, the age of the stars can be calculated.

Vandenberg said the oldest reliably dated stars, in globular cluster M92, were most likely 15 billion years old. Uncertainties in the determination of the distances to the clusters — effecting calculations of the stars' luminosities — might permit an age of 12 or even 13 billion years. But he asserted that the ages could not be much younger than that. New observations of his in globular cluster M13 did not alter this assessment.

The session also featured a talk by Wendy Freedman of the Carnegie Institute, who presented new Hubble Space Telescope results based on measurements of galaxies in the Fornax cluster, at a distance of 60 million light years. Freeman reported at a NASA press conference in early May that she and her colleagues were finding that values for the Hubble constant (H), a measure of the expansion of the universe, hovered in the range 68 to 78 km/sec/Mpc. (In 1994, they reported a preliminary value of 80.) A separate group led by Allan Sandage, also of Carnegie, recently reported a Hubble constant of 57.

Freedman's team is midway through a three-year program of measuring the distance to 20 distant galaxies by observing Cepheid variable stars, whose intrinsic brightness is related to the rate at which their luminosity varies. These observations in turn can be used to calibrate other means for determining distances to objects at even larger scales where local gravitational interactions have a lesser impact on a calculation of H. The secondary yardstick methods include the determination of the peak brightness of type-Ia supernovas and the use of the Tully-Fisher relation, according to which a galaxy's luminosity is related to its rotation rate. The latest entry in Freedman's inventory is galaxy NGC1365 in the Fornax cluster.

Stockpile Stewardship, Non-Proliferation Policies Pose Challenges to Nuclear Weapons Labs

Nuclear weapons scientists in the U.S. face a unique technical challenge in supporting twin national policy objectives: to enhance nonproliferation goals and global security through the Nuclear Non-Proliferation Treaty (NPT) and a negotiated Comprehensive Test Ban Treaty (CTBT), while maintaining the safety and reliability of a smaller deterrent force without nuclear testing or new weapons types. Speakers at a Saturday morning session of the 1996 Joint APS/AAPT Meeting discussed some of the issues surrounding stockpile stewardship, as well as the likelihood of CTBT approval in Geneva this year.

The NPT was extended indefinitely one year ago. This treaty, signed in 1970, calls in part on Nuclear Weapons States (NWS) to work towards the disarmament of their existing nuclear weapons. Critics of this indefinite extension feel that the NWS will not be under regular pressure to do so by all the NPT signatories if there is no regular reassessment of the status of disarmament. Peter Pella, a former William Foster Fellow who worked with the Arms Control Disarmament Agency on the NPT, maintained that countries will pursue nuclear disarmament as a goal only if they feel it is in their national interests to do so, and that the permanence of NPT along with other measures will enhance security and speed up the disarmament process.

A comprehensive ban on nuclear explosive testing has been the quest of scientists and statement for more than 40 years, according to John D. Holum, director of the U.S. Arms Control and Disarmament Agency. The Conference on Disarmament in Geneva is close to reaching this goal, and the U.N. General Assembly hopes to open the treaty for signature before the 51st General Assembly convenes in September. A major obstacle to be overcome is China's reluctance to move ahead, particularly its insistence on the right to conduct peaceful nuclear explosions, which Holum described as "the atomic equivalent of a friendly punch in the nose."

Many have characterized the CTBT chiefly as a nonproliferation measure, but Holum believes its great practical impact will also be for arms control — to end development of advanced new nuclear weapons and keep new military applications from emerging. "By fending off such developments, the CTBT will help make nuclear war less likely, and sustain today's trend toward smaller nuclear arsenals with shrinking roles in national defenses," he said.

Last October, President Clinton directed the DOE weapons laboratories to maintain scientific capabilities adequate to maintain the U.S. stockpile, building on his 1993 decision to develop "stockpile stewardship" without nuclear testing. Stockpile stewardship can help assure the safety and reliability of the U.S. nuclear deterrent, according to John Immele, director of the nuclear weapons technology program at Los Alamos National Laboratory. However, global attention to the control of nuclear materials, including reactor-grade plutonium, and some

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OPINION

APS VIEWS

WHY ENCOURAGE WOMEN TO ENTER PHYSICS?

by Katharine B. Gebbie, Chair, APS Committee on the Status of Women in Physics

The Committee on the Status of Women in Physics was founded 24 years ago to address the production, retention, and career development of women physicists and to gather and maintain data on women in physics in support of these objectives. To this end, the Committee sponsors a diverse array of projects including the quarterly *CSWP Gazette*, which has a circulation of more than 4,000; a Roster of Women in Physics to assist institutions in finding qualified women candidates for job openings; the CSWP/AAPT site visit project, aimed at improving the climate for women in university physics departments; WIPHYS, an Internet listserver for women in physics with more than 600 subscribers; and a new project to compile an archive of the Contributions of Women to Physics 1898-1998, to demonstrate that women, as well as men, have been major players in the scientific endeavor. And, the number and percentage of women in physics have indeed increased.

Yet in the present job market, the question may reasonably be asked, Why encourage women to make careers in physics? Is it fair to them? Will they not simply swell the numbers of unemployed and underemployed physicists? J. Robert Schrieffer, APS President, gave the following answer to these questions:

> "*... We believe that our goal of advancing and diffusing the knowledge of physics is best served if the profession draws upon the widest possible spectrum of talented individuals. We are therefore committed to removing barriers that limit the participation of women in physics and to making available to women the same range of career choices traditionally open to men. Women have the right, the need and the talent to compete for these opportunities...*"
>
> (excerpt from the April 1996 *Physics and Society* newsletter)

Members of CSWP have also addressed the question of why we are encouraging women into physics when jobs are scarce. Here are three views:

> "*The health of a field is determined by the quality of people who go into it, and physics cannot achieve and maintain excellence without drawing the best and the brightest from all segments of society. Thus an increased female presence has the potential to improve the quality of the physics workforce. If we believe that the field of physics is (or should be) a meritocracy, and if making the field more open to the entry of bright women were to reduce opportunities for some men, it would presumably be the mediocre who find themselves squeezed out. Surely the reasons why women should be encouraged to enter physics are the same as why men should be so encouraged—intellectual satisfaction, and an opportunity to make a difference in the world by the use of one's talents and energy. Why should men have all the fun?*"
>
> —Laurie McNeil
> Gordon Gray Professor of Physics and Astronomy
> University of North Carolina, Chapel Hill

> "*The next generation of physical scientists, we know from our research, has grown up, been educated, and wishes to live in a co-ed profession. Young people are thoroughly co-ed in their perceptions of the field. They are the future. And their future includes women as equal partners at home and in the workplace. Therefore, the notion that women should (or could) be "discouraged" from entering physics flies in the face of women's abilities and ambitions and of the needs of the field. The problem isn't oversupply; it's insufficient new job creation in physics. In my view women are as likely to contribute to new job creation as men.*"
>
> —Sheila Tobias
> Co-author of "Rethinking Science as a Career: Perceptions and Realities in the Physical Sciences," (Research Corporation, 1995)

> "*No one should be encouraged to "go into" physics. You should pursue a career in physics when you are called to it - when your love for the beauty of this way of looking at the world makes other choices impossible. It is not supposed to be easy. Except for a few extraordinary times in history, it hasn't been. But everyone should be encouraged to explore physics, to learn about it, and to have the chance to learn to love it. The wrong that the CSWP tries to set right is that at every level of our educational and professional structure, there are obstacles that make it more difficult for women than for men to have this opportunity. If we can remove these barriers, then more women will be called to physics careers. Indeed, this may make it more difficult for everyone who is called. At the same time, however, I believe that new opportunities for careers in physics will open up. This is a critical time for the future of science in the United States.*"
>
> —Howard Georgi
> Harvard University

If science is to thrive, we must make it our goal to achieve a scientifically literate society, a population that understands and values the contributions that science can make to our national well-being. Women are half that population. Only when women see that women are participating fully in the scientific endeavor—as researchers in the laboratory, as scientific leaders, and as policy makers—will they feel equal partners in a technological society.

LETTERS

Foreign Students Do Impact Job Market

I would like to comment on the letter in the March 1996 issue entitled "Don't Blame Foreigners for Job Problems," by Munawar Karim. Karim asserts that xenophobia fuels the concern with the effect of foreign-born scientists and engineers. It is insulting to U.S. citizen physicists when Karim says that "the standards of Ph.D. qualifying exams are occasionally lowered to allow U.S. students to pass in order to preserve balance." This suggests that the credentials of U.S. citizen Ph.D.s (mine, for example) may be suspect, and seems to imply that foreign graduates may actually be preferable.

I do recognize that fewer able Americans are choosing physics, both at the undergraduate and graduate level. I believe there are good reasons for this that have little to do with the adequacy of basic schooling. In many cases, undergraduate programs are neglected by faculties which emphasize research and graduate programs. I was fortunate to major in physics at a university where the faculty was committed to undergraduate teaching, and labs were handled by professors or full-time instructors.

On considering graduate school, potential students must weigh the considerable investment in time against the likelihood of finding appropriate employment. Karim says that physics students should expect long hours, low pay and job insecurity, and this is a description of an immigrant's work. Yes, all of these items must be accepted, to a degree. There are at least two factors concerning pay and security which, in my opinion, may favor some foreign students.

First, U.S. tax treaties with some foreign governments exempt assistantships from U.S. taxes. Citizens of these countries in effect receive more income than U.S. citizens or foreigners who must pay tax. Karim suggests that low pay is part of the bargain, but now it seems that income is even lower for U.S. citizens than for some foreign students. The second factor I see as favoring some foreign students is the "fall-back" position. In general, U.S. citizens are restricted to the U.S. job market. Foreign nationals can make an attempt to crack the U.S. market, and then return home if they do not succeed here.

I believe that the physics graduate education establishment will eventually be unable to justify expending considerable resources to educate a preponderantly foreign student base, many of whom are not able to pursue careers for which they were trained. We must address this issue.

Arnold R. Moodenbaugh
Westhampton, New York

Given that the APS is spending a substantial amount of effort to re-orient physicists in other technical careers, I would be curious to know why the Society does not take a stand on the importation of more foreign-born scientists and engineers.

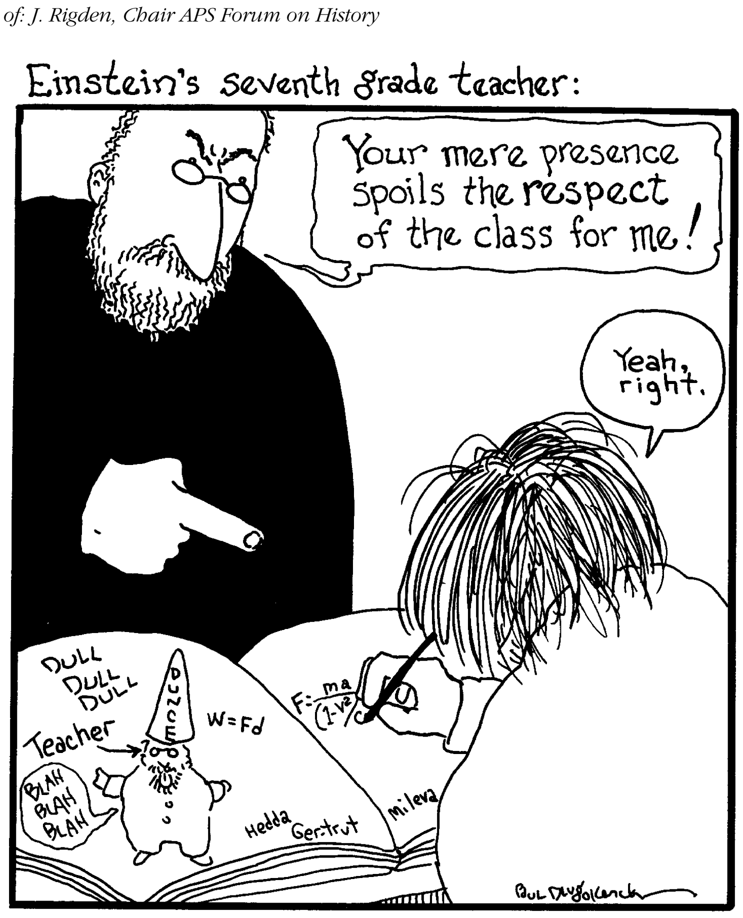
Stephen M. Hohs
San Jose, California

Historical FACTOIDS

Wilhelm C. Roentgen, the discoverer of X rays, was expelled from high school at age 18; he studied for his high school equivalency exam, took it, and failed; he prepared for an entrance exam to Zurich's ETH, but never took it. He was admitted to the ETH through the help of a friendly professor.

"Your mere presence spoils the respect of the class for me." Said by a seventh grade teacher at the Luitpold Gymnasium in Munich to his student Albert Einstein.

Courtesy of: J. Rigden, Chair APS Forum on History



Non-Proliferation Policies Pose Challenges to Nuclear Weapons Labs

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cooperation among the nuclear states in crafting post-Cold War security regime are also essential to reducing the nuclear danger.

A science-based program of evaluation, assessment and expert judgment is a primary requirement for the U.S. to enter safely into a test ban treaty. "For the first time in history, because of advances in science and technology, including computing and experimental simulation, the underpinnings needed for stockpile safety and reliability under a comprehensive test ban treaty may have finally come within reach," said Immele. "Although the task is difficult and some risks exist, science-based stewardship of the nation's remaining nuclear weapons is now feasible in an environment of no testing and no new weapons."

Immele believes that effective stewardship programs will require several complementary efforts at the national laboratories, including advances in high-performance computing; enhanced surveillance to predict aging and other defects; improved non-nuclear testing with high explosives; archiving of past design, testing and materials data; and scheduled revalidation and life-extension for the seven basic weapon designs in the continuing U.S. stockpile.

Energy Alternatives Vital To Meet Future Demands

The world population will have to increasingly rely on all forms of energy to meet future energy demands, according to speakers at a Monday morning session at the 1996 Joint APS/AAPT Meeting in Indianapolis, Indiana. The Clinton Administration promotes the development and deployment of renewable energy resources and technologies such as photovoltaics, wind, solar thermal, biomass, geothermal and hydropower energy options, with particular applications being tailored to certain local situations and needs.

During the energy crisis of the 1970s and 1980s, scientists in the U.S. began examining ways to make new products more energy efficient. The result: the U.S. doubled the efficiency of most new products and reduced energy bills by close to 50 percent. Arthur Rosenfeld, senior advisor at the U.S. Department of Energy, discussed new scientific strategies for improving the energy and economic savings even further. "The potential for future savings through energy efficiency is even larger if we change utility profit rates," he said, pointing out that in California, it is far more profitable for utilities to sell efficiency than to sell raw energy.

Improving technological performance and reductions in associated energy costs have enabled renewables to be low-cost options for generating power under certain conditions. Also driving their increased deployment are environmental concerns, future energy security, and the recognition that renewables are competing for a total target market ranging in the trillions of dollars, according to the DOE's Allan Hoffman. The World Bank has estimated that over the next 30-40 years, developing countries alone will require 5 million megawatts of new generating capacity, compared with today's total world capacity of about 3 million megawatts, at a capital cost of between $1000 and $2000 per kilowatt.

"The environmental implications of that much capacity using fossil fuels, even in the more benign form of natural gas, are severe," said Hoffman. "If we are to minimize adverse local and global environmental impacts from the inevitable powering up of developing nations, renewable forms of non-polluting and non-greenhouse-gas-emitting systems must be widely used." He predicts a gradual transition to a global energy system that is largely dependent on renewably energy within 100 years, with hydrogen possibly emerging as an important energy carrier to complement electricity because of its ability to be used in all end-use sectors and its benign environmental characteristics.

According to Rosenberg, several promising new strategies are ready for implementation, including the use of cooler roofing and paving materials, and shade trees to reduce air conditioning load, reverse the urban heat island effect, and reduce smog. The DOE will showcase various commercially available renewable technologies at the 1996 Summer Olympic Games in Atlanta, Georgia, this summer, including photovoltaics, solar/thermal dish generators, fuel cells, and alternative fuel vehicles. In addition, three new energy efficient technologies have recently been developed: high-frequency ballasts, compact fluorescent lamps, and low-energy windows.

Energy efficient windows were first introduced commercially in the early 1980s, and Rosenberg estimates cumulative volume sales since then at about 1.7 billion square feet, with a cumulative savings of about $1.8 billion. Recent improvements have resulted in a new design for these windows, consisting of three glazing layers, two coatings, and a filling of argon or xenon gas, providing excellent optics and durability at a low cost to manufacturers. In the future, he expects the commercial availability of energy efficient windows with electric chromates that allow for clear glass as well as adjustment of light.

John Sheffield from Oak Ridge National Laboratory postulated that with the likely depletion of most fossil fuels by 2100, alternate energy sources will be developed according to the region's indigenous resources, and that in many regions, fusion energy will probably be one of the technological goals. Based on the World Bank population projections, he believes that all alternative energy sources will be needed to meet future energy demands, and thus supports continued investment in fusion energy research. He estimates the first fusion plants could become operational around 2050, most likely in those countries, such as Japan and Europe, that have already deployed substantial nuclear power and will need more as cheap fossil fuel becomes less available.

MULTIMEDIA REVIEW

by Ben Stein

A Brief History of Time: An Interactive Adventure and ***The Cartoon Guide to Physics*** (CD-ROM)

Dealing as it does with the dynamic flow of matter and energy in our universe, physics is a natural candidate for multimedia, electronic presentations combining text, graphics, animation, sound, and music. At its best, multimedia can convey ideas with a vividness practically unrealizable on paper or blackboard. As CD-ROM-equipped home computers become increasingly widespread in the U.S., software companies are starting to ship multimedia versions of bestselling books. Popular books on physics are now receiving the multimedia treatment, and both titles tested for this month's column are very good.

A Brief History of Time: An Interactive Adventure (Scientific American/W.H. Freeman, $49.95) is the CD-ROM version of Stephen Hawking's 1988 bestseller that traces humankind's discoveries on the nature of space-time. Largely modelled after the 11-chapter book, and utilizing video and sound from the stylish Errol Morris movie adaptation, the CD-ROM employs ample narration by the author, beautiful graphics and animated thought experiments to flesh out the often-difficult concepts in Hawking's popular work. Chapter One, entitled "Our Picture of the Universe," contains a gallery of famous philosophers and physicists in history. Clicking on Aristotle begins a slide presentation, narrated by the speech-synthesizer-aided Stephen Hawking, describing how the Greek philosopher convincingly argued that the Earth is round by appealing to the round shadows the Earth makes when it eclipses the moon.

In "Relativity Street," an animated version of Albert Einstein recalls how he was inspired with the idea of relativity after talking to a painter who had fallen off a roof. A subsequent thought experiment on relativity shows Einstein playing a game of ping-pong inside a trolley heading towards the edge of a cliff. From Einstein's point of view, the path of the airborne ping-pong ball seems to change as the trolley goes into free fall, but from the outside we can see that the ball would follow the same trajectory if the trolley had continued to travel on the rails. In a humorous live-action skit elsewhere in the chapter, Marilyn Monroe seductively describes a thought experiment on special relativity to a receptive Einstein.

Another section of the program allows one to take a trip aboard a spaceship to the suspected black hole Cygnus X-1. On the way to a beautiful rendition of the swirling galaxy surrounding Cygnus X-1, video clips play as physicist John Wheeler and others describe the properties of black holes and what it would be like for an astronaut to fall inside one. There also is a well-done biography section of Hawking discussing his affliction with Lou Gehrig's disease and his decision to live life to the fullest and become a serious scientist. The complete text of the book can be found on the disc, with links to the appropriate graphics and animations.

Much lighter is the CD-ROM version of ***The Cartoon Guide to Physics*** (HarperCollins Interactive, $39.95), based on the popular book by Larry Gonick and Art Huffman. Suitable for anyone who is receiving his or her first introduction to physics, the *Cartoon Guide* offers clear and correct lessons in basic mechanics, covering such topics as Newton's Laws, energy and momentum. To its credit, the program doesn't shy away from displaying basic equations and even performing simple mathematical derivations.

Each physics lesson consists of animated black and white vignettes narrated by a live-action character named Lucy and demonstrated by an accident-prone cartoon figure named Ringo. These are very much like animated versions of Gonick's popular cartoon books and bimonthly columns in *Discover.* The lesson on Newton's Third Law begins as Isaac Newton chisels the formal versions of his three laws on a stone tablet. Then, in Monty Pythonesque fashion, a block of letters falls from on high reading, "Action equals reaction." The lesson shows how a horse manages to pull a cart even though, at first sight, the two seem to exert forces that cancel out each other. Other examples show the forces involved when a book is held up on a table, and the way in which a space shuttle is pushed up by exhaust gases.

A section of the program entitled "The Workshop" consists of five games intended to give the user a feel for such properties as inertia, projectile motion, and potential and kinetic energy. I found this to be the weakest part of the program, as the games are kind of basic and not very fun. In the Hall of Fame section, Lucy and Ringo stand next to busts of ancient, classical, and modern scientists and converse on the achievements and importance of each. Finally, a glossary contains good working definitions of the terms encountered on the disc. The animation on this disc is smooth and seamless.

System requirements:

A Brief History of Time: An Interactive Adventure, Scientific American/W.H. Freeman (1-800-777-0444). Windows version requires a 386 SX or faster, VGA color monitor and graphics card running at 256 colors, 8 MB RAM, Windows 3.1, SoundBlaster or a compatible sound card, mouse, double-speed CD-ROM drive. Macintosh version requires an LCII or faster, including Performa, Quadra, and PowerMac series, 256 color monitor at least 13", system 7.0 or later, double speed CD-ROM drive.

The Cartoon Guide to Physics, HarperCollins Interactive (800-424-6234). Windows users require a 486/33 or compatible with hard disk drive, Microsoft Windows 3.1, 8 MB RAM, 5 MB free hard disk space, 256-color or higher graphics card, 14" SVGA monitor, double speed CD ROM drive, MPC compatible sound card and speakers. Macintosh version requires 25 MHz 68030 or better, 8 MB RAM, 13" 256-color monitor, double speed CD-ROM.

Ben Stein is a science writer in AIP's Public Information Division.

Highlights from Indianapolis

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up tentative evidence of neutrino oscillation, a phenomenon in which one type of neutrino (muon, electron, or tau neutrino) transforms into another. According to LANL's Fred Federspiel, the observation of the new data cannot be attributed to either known background processes or to statistical fluctuations, since the total estimated background from cosmic rays and other neutrinoes is only about four or five events. The team is also analyzing data on neutrinos produced by pions and muons decaying in flight, which have higher energies, and expects to continue collecting data with their detector over the next two years.

Record High Laser Intensity. The advent of tabletop terawatt lasers has prompted the study of new nonlinear optical effects. Donald Umstadter of the University of Michigan reported on an experiment in which a self-focusing laser beam passing through a plasma reached an intensity of 10^{20} W/cm^2, the highest yet reported for any laser. In the process of excluding plasma electrons from a narrow region forming a thin channel through the plasma, the laser creates pressures exceeding one giga-bar, higher than any other man made pressure. The collimated and intense laser beams will eventually be used in attempts to accelerate electrons to GeV energies over a space of centimeters. A new generation of ultrashort duration high-energy electron and photon courses may thus be built, potentially the equivalent of a Stanford Linear Accelerator or Advanced Proton Source on a tabletop.

Crystalline Beams. In a Thursday morning session on advances in beams and accelerators, Jeffrey Hangst of Aarhus University in Denmark reported on efforts to cool the relative motion of particles in a circulating beam, as well as the use of resonant laser light as a diagnostic tool for studying fundamental issues in beam dynamics. According to Hangst, the great strength and speed of the laser cooling process have led scientists to believe it could be used to produce a crystalline beam, in which the ions' relative kinetic energy decreases to the point that an ordered state is formed. He summarized recent experimental progress in this area, as well as current theoretical understanding of the conditions under which a spatially ordered ion beam might be obtained.

Delta-Enhanced Multifragmentation. Scientists at Indiana University have obtained the first direct evidence for the expansion of nuclear matter using proton and helium beams from particle accelerators to heat atomic nuclei to several billion degrees. The fragments produced in the process were then analyzed with the Indiana Silicon Sphere Detector, an array consisting of 162 "telescopes" for identifying nuclear fragments formed in the disintegration of hot nuclei. The Indiana researchers concluded that the nucleus expands as much as 50 percent of its normal size before breaking apart, which corresponds to a density about one-third of normal nuclear matter. The results are relevant not only to the understanding of microscopic nuclei, but also to cosmological problems, such as supernovae and the formation of neutron stars, pulsars, or possibly black holes.

Superdeformed Nuclei. When two nuclei collide off-center, they can fuse to create a superdeformed nucleus: a football-shaped nucleus with a large amount of spin, according to scientists at Lawrence Berkeley Laboratory. Using the GAMMASPHERE detector at LBL, Teng Lek Khoo of Argonne National Laboratory and his colleagues have measured, for the first time, the total energy and angular momentum released when a superdeformed mercury-194 nucleus decays to a well-understood, lower-energy nuclear state. According to Khoo, connecting these two states paves the way toward understanding the many mysteries associated with this nuclear state.

Supersymmetry. Supersymmetry is a theory that seeks to unite quantum mechanics with general relativity. An important ingredient is the existence of certain hypothetical particles. According to the theory, each known fermion — such as an electron and quarks with a half integral spin — would have a new boson counterpart. Likewise, all known bosons — particles such as photons with integral spin — would have new fermion counterparts. Gordon Kane of the University of Michigan discussed how supersymmetry theory could be put to the test, and how certain events recorded in scattering experiments at Fermilab may already provide the first hints of supersymmetry at work.

Materials at Intense Pressures. Scientists at Los Alamos are probing the limits of experimental physics on extreme states of matter using magnetic flux compression, a technique for converting the chemical energy released by high explosives into intense electrical pulses and intensely concentrated magnetic energy. The pulse generators reach magnetic fields in excess of 1000 Tesla. Using the technique, the researchers have made discoveries about several properties of materials observed at the atomic level, including the quantum Hall effect, Faraday rotation and magnetic-field induced superconductivity. These experiments may provide answers to questions in astrophysics and planetary physics, such as clues to the state of matter inside the great gas giant planets, as well as new directions in materials science and solid state physics. Researchers will next attempt to compress argon up to 8 million atmospheres to observe the rising stages of conductivity in the gas, possibly leading to the production of metallic argon, a phase state never before seen on Earth. Until recently, the technique has been used primarily for nuclear weapons research.

Forecasting Individual Storms. Present weather models used in National Weather Service Operations employ a grid resolution of 45-60 kilometers, which is sufficient to forecast larger-scale features, such as fronts and low-pressure systems, but not enough to anticipate isolated storms over specific counties or cities. Kelvin Droegemeier of the University of Oklahoma has developed a new computational model that provides storm forecasts up to six hours in advance, with up to one-km resolution. This may lead to enabling forecasters to predict individual storms, which can be around five km in size.

Unlike present weather models the new model takes into account vertical accelerations, which are generally not negligible for storms, where the vertical wind velocity can be as strong as the horizontal wind velocity. The system was tested over the Southern Great Plains last year and will be run again this year during collaborative testing with American Airlines over their major hubs in Dallas and Chicago. The tests will help determine whether this model can be used to reduce the number of needlessly rerouted plane flights.

Colliding Beam Fusion. Conventional nuclear fusion reactions are initiated by magnetically confining a deuterium and tritium plasma and introducing energy sources to generate the high-temperature conditions necessary for fusion. Norman Rostoker of the University of California-Irvine proposed that researchers should consider conducting experiments that explore the possibility of using exclusively high-energy particles to create fusion.

Experiments have shown that when a small amount of high-energy particles are trapped in a magnetic field, they are confined for long periods of time. With longer confinement times, fusion is easier to achieve. According to Rostoker, this approach could open the possibility of fusing hydrogen with isotopes such as boron-11. It would produce charged-particle by-products that are have advantages over the neutrons that result from the traditionally used deuterium-tritium fuels.

New Measurements of G. Conflicting measurements of Newton's constant G, which relates the gravitational force between two objects to their mass and separation, were presented at the 1995 APS/AAPT Spring Meeting (see *APS News*, July 1995); the highest discrepancy was more than half a percent greater than the accepted CODATA value. The results have stimulated a number of new measurements of G by various groups worldwide. For example, a group at Wuppertal University in Germany is improving their ability to measure their source mass position, and plans to move their apparatus to another site where temperature and noise level control will be better. Also underway are measurement experiments at Zurich University, University of California, Irvine, the University of Washington, and JILA in Boulder, Colorado, as well as in Russia, Taiwan and Japan.

Accelerators in Industry. Phil Womble of Oak Ridge National Laboratory described a technique for detecting "remote-handled transuranic waste," which are neutron-emitting radioactive by-products, heavier than uranium, and a significant component of nuclear waste produced at Argonne National Laboratory and elsewhere. In the new technique, a compact accelerator generates a tiny amount of fission in the waste, creating by-products that help identify isotopes in the sample. In the same session, George Vourvopoulos of Western Kentucky University discussed how neutrons produced by compact accelerators can be used to perform real-time analysis of coal to help testing and blending of different types of coal. The technique can also be used to burn coal economically and environmentally safety, as well as to test coal by-products, such as ash.

Nontechnical Sessions.

Effects on Radiation at Low Doses. In 1928, the International Commission on Radiological Protection advised that for prudent public protection, no amount of radiation should be accepted without expectation of benefit, based on 1924 studies by physicist Jeffrey Crowther that showed linearity at low doses. However, this cautious approach is based on direct epidemiological data obtained from studies at high radiation doses, since a large number of test subjects would be needed to find a small effect low doses, with considerable bioassay effects. In a Sunday morning session, Bernard Cohen of the University of Pittsburgh reviewed two possible approaches to study the linear-no threshold theory (LNT) of radiation carcinogenesis in the low dose region.

The best approach, according to Cohen, is use of the radon vs. lung cancer relationship, but these studies have not been sufficiently robust to extrapolate meaningful conclusions from the data. An alternative is to study lung cancer rates for various counties and compare them to average radon exposure in those counties. Cohen has found that regardless of corrections for smoking prevalence, the mortality rate actually decreased with increasing radiation doses, in sharp contrast to predictions, with a standard deviation factor of 20. This discrepancy lead to the conclusion that the LNT theory may well fail in the low dose region.

Science, Politics and Human Rights. Where does one draw the line between scientific activity and complicity with a totalitarian regime? Nicholson Medal recipient Yuri Orlov of Cornell University examined the ethical decisions a scientist must face when confronted by political realities that make the pursuit of science morally challenging and/or professionally difficult. In 1986, Orlov was stripped of USSR citizenship and deported to the U.S., where he has continued to be active in the human rights arena while doing physics research at Cornell. He discussed the implications associated with speaking out, and extended the moral dilemma to U.S. scientists who must decide whether or not to collaborate with colleagues who hold positions of high power in repressive regimes.

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

1996 JOINT MEETING PROGRAM COMMITTEE:

Chair: David Cassell, Cornell University; **Vice-Chair:** Virginia Brown, Lawrence Livermore Laboratory; **AAPT Program Chair:** Ronald Edge, University of South Carolina; **APS:** Judy Franz,; **Program Committee:** Beverly Berger, Oakland University (GTG); Fred Dylla, CEBAF (FIAP); Robert Erdman, Keithley Instruments, Inc. (IMSTG); Charles Falco, University of Arizona (FIP); Richard Freeman, AT&T Bell Laboratories (DAMOP); Joan Frye, Howard University (COM); Katherine Gebbie, NIST (CSWP); Edward Gerjuoy, University of Pittsburgh (FPS); Paul Grannis, SUNY-Stony Brook (DPF); Geoffrey Greene, NIST (PCMTG); Franz Gross, College of William & Mary (FBSTG); Beverly Hartline, CEBAF (FED); Wick Haxton, University of Washington, (DAP); Richard Hazeltine, University of Texas (DPP); Barry Klein, University of California-Davis (DCOMP); Claudio Pelegrini, University of California-Los Angeles (DPB); Lee L. Riedinger, University of Tennessee (DNP); John Rigden, American Institute of Physics (FHP); and Steven Sibener, University of Chicago (DCP).

Meeting arrangements were made by Michael Scanlan and Tammany Buckwalter of the APS Meetings Department.

General Election Preview: Members To Choose New Leadership for 1997

The membership of The American Physical Society will elect a Vice President, a Chair-Elect of the Nominating Committee, and four General Councillors in the 1997 General Election. Ballots must be received by the 8 September deadline in order to be valid. A slate of candidates has been prepared by the Nominating Committee, and biographical summaries for each are provided below. Full biographical information and candidates' statements are printed in the ballot.

FOR VICE PRESIDENT

Jerome I. Friedman
Massachusetts Institute of Technology

Friedman received his Ph.D. in experimental particle physics from the University in Chicago in 1956. After a year as a research associate there, he accepted a three-year appointment at Stanford University. In 1960, he joined the MIT faculty as an assistant professor, where he has served as director of the Laboratory for Nuclear Science and as head of the physics department. His research has included studies of particle structure and interactions with high-energy electrons, neutrinos and hadrons. Recipient of the Society's W.H.K. Panofsky Prize in 1989, he shared the 1990 Nobel Prize in Physics with Henry Kendall and Richard Taylor. Friedman's professional activities include service as vice-chair of the Board of the University Research Association, and on the National Research Council's Board on Physics and Astronomy, as well as the APS Physics Planning Committee.

David N. Schramm
University of Chicago

Schramm received his S.B. from MIT in 1967 and his Ph.D. in 1971 from Caltech, where he remained as a postdoctoral fellow for the following year. After a two-year stint as an assistant professor at the University of Texas at Austin, he joined the faculty of the University of Chicago, where he is currently the Louis Block Professor of Physical Sciences. He chaired the department from 1979 to 1985, and in 1995 became vice president for research, with responsibilities at Argonne National Laboratory as well as the university. He also co-founded the astrophysics group at Fermilab. His research has included numerous topics in theoretical astrophysics and cosmology, as well as the interface of these subjects with nuclear and elementary particle physics. He was elected to the National Academy of Sciences in 1986. He is the recipient of numerous awards, most recently the 1993 APS Lilienfeld Prize. Schramm currently chairs the NRC's Board on Physics and Astronomy.

FOR CHAIR-ELECT OF THE NOMINATING COMMITTEE

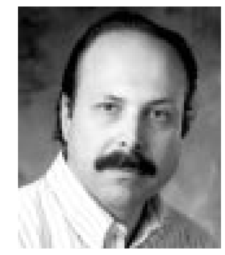
Wick Haxton
University of Washington

Haxton received his Ph.D. in physics from Stanford University in 1976. He spent 1977 as a research associate at the Universität Mainz followed by seven years as a research associate, Oppenheimer Fellow, and staff member in the Theory Division of Los Alamos National Laboratory. He spent one year as an assistant professor at Purdue University (1980-81), and returned to teaching in 1984 at the University of Washington, where he is currently a professor of physics and director of the Institute for Nuclear Theory. His research interests include atomic and nuclear tests of symmetry principles and conservation laws, nuclear astrophysics issues, and many-body techniques. Haxton chaired the Division of Nuclear Physics in 1992 and currently chairs the Division of Astrophysics. He is currently an editor of *Physics Letters B* and is a former General Councillor.

John W. Wilkins
Ohio State University

A University of Illinois Ph.D., Wilkins joined the Cornell University physics department in 1964 after a year-long postdoc at Cambridge University. He was traded for a draft choice in 1988 to Ohio State University. Only with the assistance of over 70 graduate students and postdocs, could he have rambled from superconductors to metals to semiconductors, sampling many excitations processes by single-particle and many-body paths. Within the APS his primary concern has been publications with service both on *Reviews of Modern Physics*, *Physical Review B* and *Physical Review Letters* and in the oversight and review of APS journals. But he also had to endure a term on both the Council and the Executive Board. Unbelievably he is a founding member of the Division of Biological Physics, a field in which he has never worked.

FOR GENERAL COUNCILLOR



David D. Awschalom
University of California, Santa Barbara

Awschalom received his Ph.D. in experimental physics from Cornell University, and was a research staff member and manager of the Nonequilibrium Physics Group at the IBM T.J. Watson Research Center. In 1991 he joined the faculty of the University of California, Santa Barbara, as a professor of physics, where he is also a member and program coordinator for magnetism and superconductivity in the Science and Technology Center for Quantized Electronic Structures. His research interests center on exploring electronic and magnetic interactions in semiconductor quantum structures, as well as the classical and quantum mechanical properties of mesoscopic magnetic systems.

James Ball
Oak Ridge National Laboratory

Ball received his Ph.D. from the University of Washington in 1958, joining Oak Ridge National Laboratory as a postdoctoral associate that same year, and soon became a permanent staff member. He has remained at ORNL for most of his career, serving as director of the Holifield Heavy Ion Facility until

(Continued on page 10)

Nomination Ballot—1997 Bylaw Committees

To be Completed Only by Members of The American Physical Society (please complete both sides)

The Committee on Committees has the responsibility for nominating elected members of the Publications Oversight Committee and advising the President concerning suitable candidates for service on all other Bylaw Committees appointed by the President. Information on the Committees and their present membership appears on the APS home page under Governance.

The Committee needs input from the membership. **Please provide the name and affiliation of nominees and attach information on career highlights and suitability of the nominee for the particular committee indicated. Nominees must be APS members. Self-nominations are strongly encouraged.**

The deadline for receipt of nominations is 9 August 1996.

For Membership on the Committee on Constitution & Bylaws:

For Membership on the Committee on Education:

For Membership on the Committee on Applications of Physics:

For Membership on the Committee on Fellowship:

For Membership on the Committee on International Scientific Affairs:

For Membership on the Committee on International Freedom of Scientists:

For Membership on the Investment Committee:

For Membership on the Publications Oversight Committee:

Continued on Reverse

General Election Preview

1983, when he was named director of the Physics Division. His primary research interests are in nuclear structure with direct reactions, two-nucleon transfer reactions, heavy ion reaction mechanisms, shell model treatment of the A=90 region of nuclei, and accelerator physics. A former chair of the APS Division of Nuclear Physics, he also served three years as the general program chair for the APS/AAPT Joint Meeting.

S. James Gates
University of Maryland

Gates received his Ph.D. in physics from MIT in 1977, and spent the next three years doing postgraduate research as a junior fellow of the Harvard Society of Fellows. He spent two years on the faculty of MIT's mathematics department before joining the physics department of the University of Maryland at College Park. His research centers on investigations of the mathematical properties and realizations of supersymmetry in quantum and classical theories of particles, fields and strings, and co-authored *Superspace*, the first advanced comprehensive book on supersymmetry. Gates was the first director of the NASA-supported Center for the Study of Terrestrial and extra-Terrestrial Atmospheres, and was the recipient of the first APS Edward Bouchet Award.

Paul S. Peercy
SEMI/SEMATECH

Peercy received his Ph.D. in physics from the University of Wisconsin at Madison in 1966, and spent the next two years as a postdoctoral fellow at Bell Laboratories. In 1968 he joined Sandia National Laboratories, performing research in such solid state physics areas as plasma in solids, inelastic light scatting in solids, phase transformations and ferroelectricity, and semiconductor physics. Most recently he served as Sandia's director of microelectronics and photonics, with responsibility for its silicon, compound semiconductor, sensor and packaging R&D activities. In August 1995 he left Sandia to assume the presidency of SEMI/SEMATECH, a consortium of more than 200 companies that provide the U.S. equipment and materials supplier base for the semiconductor device manufacturing industry.

Chris Quigg
Fermi National Accelerator Laboratory

Quigg received his Ph.D. in theoretical particle physics from the University of California, Berkeley in 1970, and spent the next four years as a member of SUNY-Stony Brook's Institute for Theoretical Physics. Since 1974 he has been associated with Fermilab, heading the Theoretical Physics Department from 1977 to 1987. Until 1991, he was also on the faculty of the University of Chicago. His research emphasizes the essential interplay between theory and experimentation, including such topics as electroweak symmetry breaking, properties and interactions of heavy quarks, and high-energy particle collisions. Quigg has served on the executive committee of the APS Division of Particles and Fields, and as an associate editor for both *Physical Review Letters* and *Reviews of Modern Physics*.

Ravi Sudan
Cornell University

Sudan received his Ph.D. from Imperial College at the University of London. After working a few years in England and India in industry, he joined the faculty of Cornell University where he is the IBM Professor of Engineering, and member of both the electrical engineering and applied physics departments. From 1975 to 1985 he served as director of the Laboratory of Plasma Studies and helped to establish the Cornell Theory and Supercomputer Center, serving as its first deputy director. His research spans all aspects of plasma physics, including thermonuclear fusion and the technology of high-powered charged particle beams. Recipient of the 1989 APS Maxwell Prize, Sudan has served on the executive committee of the APS Division of Plasma Physics, and currently chairs the National Research Council's Plasma Science Committee.

Virginia Trimble
University of Maryland/ University of California, Irvine

Trimble received her Ph.D. in astronomy from the California Institute of Technology in 1968, and presently divides her time between the physics department of the University of California, Irvine and the astronomy department of the University of Maryland. Her early research focused on advanced stages of star evolution, including white dwarfs, supernovae and pulsars. More recently she has investigated the statistical distributions of properties of binary stars and numerous topics in the history and sociology of physics and astronomy. She has served as secretary-treasurer of the APS Division of Astrophysics, and on the APS Committee on Meetings.

Sau Lan Wu
University of Wisconsin, Madison

Wu received her Ph.D. in high energy physics from Harvard University in 1970 and did her postdoctoral study at MIT. She participated in the 1974 discovery of the charm quark at Brookhaven National Laboratory, where she had previously spent a summer as an undergraduate student. She has been a faculty member in the physics department at the University of Wisconsin at Madison since 1977. She is a co-recipient of the European Physical Society's 1995 High Energy and Particle Physics Prize for the first direct observation of the gluon. She is a Fellow in the American Academy of Arts and Sciences. Wu is also a member of the DOE's High Energy Physics Advisory Panel.

For Membership on the Committee on Membership: ______________________

For Membership on the Committee on Meetings: ______________________

For Membership on the Committee on Minorities: ______________________

For Membership on the Committee on the Status of Women in Physics: ______________________

For Membership on the Physics Planning Committee: ______________________

Nominator's Information

Name: ______________________

Address: ______________________

____

Signature: ______________________

Please Address Your Envelope to:

The American Physical Society
ATTN: AMY HALSTED
One Physics Ellipse
College Park, MD 20740-3844
Fax: (301) 209-0865
Email: halsted@aps.org

The deadline for receipt of nominations is 9 August 1996.

ANNOUNCEMENTS

Now Appearing in RMP....

***Reviews of Modern Physics* is a quarterly journal featuring review articles and colloquia on a wide range of topics in physics. Titles and brief descriptions of the articles in the July 1996 issue are provided below.**

Particle physics summary. The 1996 edition of the biennially published *Review of Particle Properties* appears here in summary form. The present edition marks the completion of the table of standard-model quarks, with the discovery of the top. It also includes new sections on solar neutrinos, big-bang nucleosynthesis, and the Hubble constant.

Quantum computation and Shor's factoring algorithm. Artur Ekert and Richard Jozsa explain in simple physical terms Shor's algorithm for factorization of large umbers. The use of quantum interference to perform computations has attracted great interest among computer analysts and physicists, and this algorithm provides a striking illustration of the potential power of quantum computation.

On the measurement of a weak classical force coupled to a harmonic oscillator: experimental progress. Mark F. Bocko and Roberto Onofrio discuss quantum noise as a limiting factor in measurements with macroscopic systems, such as gravitational wave detectors. They also review recent experiments that approach this fundamental limit.

Quantum noise in photonics. C. H. Henry and R. F. Kazarinov review the basic physical phenomena associated with quantum noise in photonic processes, those processes involving the generation, amplification, transmission, and detection of light. In a style bridging the gap between physics and engineering sciences, the authors outline the important role played by quantum noise in many applications.

Nuclear magnetic resonance of C_{60} and fulleride superconductors. Charles H. Pennington and Victor A. Stenger review the contributions of nuclear magnetic resonance to our understanding of fullerite and fullerides, the materials made from C_{60} molecules. Magnetic resonance reveals unusual structural properties as well as providing insight into the mechanism for superconductivity.

Magnetic relaxation in high-temperature superconductors. Y. Yeshurun, Alexis P. Malozemoff, and A. Shaulov review the phenomenon of magnetic relaxation in high-T_C materials, which prevented realization of the early expectations for superconductivity at liquid-nitrogen temperatures. The leakage of magnetic flux from these materials has become a widely studied phenomenon in its own right, which the authors examine with emphasis on the empirical evidence.

RMP Colloquium:
The 18 arbitrary parameters of the standard model in your everyday life. Robert Cahn explores the many ways in which the 18 parameters of the standard model affect the world as we know it. While these parameters are in a sense arbitrary, slight changes in their values would drastically alter the properties of our universe.

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Fighting the Gender Gap

(continued from page 3)

she said. "They may help contribute to your decision, but they are never designed to be the sole indicator." However, institutions often ignore this dictum, as in the case of Siders' experiences with the University of Texas graduate admissions committee.

The reliance on standardized testing for admission is slowly beginning to change. FairTest compiles an annual list of four-year colleges that do not require standardized test scores, and there are currently 241, compared with 112 in 1989. While Harvard's graduate admissions committee requires both the GRE general and physics subject test, its members rely more heavily on letters of recommendation, the personal essay, and undergraduate records when deciding whom to admit.

While Siders emphatically believes that GRE requirements should be dropped for graduate admissions, Georgi favors a modified version of the GRE physics subject test, reducing the number of questions by half to give students time to think through the answers and eliminate time pressures, focusing instead on basic skills and knowledge. However, "As presently constituted, it's quite possible that the GRE physics subject test does more harm than good, and we should either fix it, or seriously consider getting rid of it altogether," he said.

IN BRIEF

- The APS Lars Onsager Prize will be awarded annually beginning in 1997. Originally endowed by Russell and Marian Donnelly as a biennial $10,000 award, the couple has decided to make additional yearly donations to fund the award until the principle grows to full endowment of the yearly prize. Until now, only the Lilienfeld and Schawlow Prizes have been annual $10,000 awards. The purpose of the Onsager Prize is to recognize outstanding research in theoretical statistical physics, including the quantum fluids.

- Physicist and human rights activist Liu Gang fled the People's Republic of China and arrived in the United States on Wednesday, May 1st, 1996. After serving a very hard six-year prison sentence, which began shortly after the massacre of non-violent protesters at Tiananmen Square on June 4th 1989, Liu was released in June of 1995. He had been third on the list of "most wanted" students involved with the democracy movement. Since his release, Liu was deprived of any chance of employment and constantly harassed by police, thus robbed of his basic human right of survival. The APS' Committee on the International Freedom of Scientists wrote numerous letters to the PRC Government concerning Liu's treatment while he was imprisoned and following his release, much of which was in violation of the Constitution of the People's Republic of China and the United Nations' Declaration on Human Rights. Liu Gang intends to start a new life in a the U.S.

- The APS New England Section held its annual spring meeting 26-27 April at MIT, organized jointly with the New England regional sections of the American Association of Physics Teachers and the Society of Physics Students. Friday afternoon's plenary session featured lectures on such topics as magnetic resonance imaging of lungs with laser polarized gases, imaging two-dimensional electrons with scanning tunneling microscopes, and the global positioning system. Saturday morning's plenary session on relativity in astrophysics featured talks on the discovery of the binary pulsar, the search for gravitational waves using laser interferometry, and detecting dark matter with gravitational lenses. Friday evening's banquet featured a keynote address by MIT's Philip Morrison, entitled "Solar Systems: Plural at Last."

- The APS New York State Section held its annual spring meeting 11-12 April at IBM's T.J. Watson Research Center, organized as a topical symposium on "21st Century Computing: Physical Basis to Classroom Applications." Friday morning featured lectures on such topics as quantum constraints on information processing, ballistic computation, and quantum computation. Friday afternoon focused on new ways of computing, such as the use of cellular automata, adiabatic design of CMOS logic, and massively parallel computing using DNA. The Friday evening banquet featured a public lecture by IBM's Rolf Landauer on 50 years of physics computation. The symposium closed with a Saturday morning plenary session on new computing environments for the classroom, covering such topics as Web technologies and high-speed communication networks, the Internet as a K-12 teaching tool, and the use of virtual reality in graduate education.

CAUGHT IN THE WEB

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

APS News Online (latest edition)

Units
- Updated FHP homepage
- Updated DCMP homepage

Membership
- Add your personal home page URL to your Member Directory Listing
- Memberships Renewals can now be done online now using our SECURE SERVER.

Meetings
- Updated APS Meetings calendar

Careers
- More job listing sites

Miscellaneous
- Help plan and prioritize the APS E-print Server
- New APS Statements on:
  - Office of Energy Research (96.1)
  - Energy: The Forgotten Crisis (96.2)
  - Plasma Physics and Fusion Science (96.3)

THE BACK PAGE

Globalization of Technology Poses Challenges for Policymakers

by Mary Lowe Good

Technology is directly linked to national economic growth, and its globalization poses difficult challenges for policymakers, not just in technology policy, but in areas such as trade and regulatory policy. Technology-related policy issues are made all the more difficult as one struggles to interpret the national interest, when much of the technology needed for national growth is developed and managed by multinational companies whose markets, operations, and sources of capital are distributed throughout the globe.

The sources of this growth — capital, technology, and even labor — are increasingly globalized. Investment capital flows around the world daily in search of the greatest returns. As an example of the globalization of labor, thousands of engineers in India are designing computer chips for America's leading firms, and beaming these designs overnight to California and Texas via satellite. As more workers telecommute on a global basis, we may well begin to ask, "What is the American workforce?"

But it is technology that contributes most to economic growth. Leading economists estimate that technology accounts for at least one half of economic growth in the advanced industrial nations over the past 50 years. This is not to say that science should take a back seat to technology. Science is an integral part of the balanced portfolio of research an advanced nation must have to ensure its long-term growth. But science alone cannot secure a nation's competitive edge. The results of basic research are available to the world — often instantaneously over the Internet — with the potential to generate economic benefits for any company capable of using those results.

In contrast, in this high stakes poker game we call global competition, technology — by virtue of its proximity to the market — must be played close to the vest. Yet as the world's nations scramble for a winning hand, technologies — in the form of products, know-how, intellectual property, people and companies — are being traded, transferred, hired, bought and sold on a global basis.

In addition to global trade in technology, technology infrastructure — once the sole domain of advanced industrial nations — is increasingly globalized as nations around the world recognize the linkage between indigenous technology assets, and economic growth and job creation. In the U.S., our attention has long been focused on the technology policies of our European and Japanese trading partners, and we have carefully examined their science and technology policies and R&D spending patterns. Support for R&D remains strong, and collaborative efforts — industry-government partnerships, as well as bilateral and multilateral cooperation — are major strategic thrusts.

While science and technology in Europe and Japan will continue to have important implications for the U.S., growth in these countries will be much slower over the next two decades than in a good deal of the rest of the world. Instead, the locus of world economic growth is shifting dramatically to places such as Argentina, Brazil and Mexico in the West, to Indonesia, South Korea and China in the East. Growth rates in these countries are expected to be phenomenal, and they are soaring now: Argentina at 7.4 percent, Indonesia at 7.3 percent, Malaysia at 8.8 percent, South Korea at 8.4 percent, Singapore at 10.2 percent, and China at 11.5 percent.

As a group, these newly industrialized countries pose a competitive challenge that could erode the high-tech position of the advanced industrial nations. They recognize the linkage between technology, growth and jobs, and view their participation in world markets for high-tech products as a matter of national pride. Many have set their sights on joining the ranks of the world's technological leaders. To that end, many have established a basic two-pronged strategy directly aimed at economic growth competitiveness: first, acquire technology from the world's leaders to compensate for inadequate science and technology infrastructures; and second, address those short-comings by aggressively developing indigenous technology resources. Many of these nations have backed up their strategies with formal development plans.

A look at South Korea offers a harbinger of things to come if these nations bring their national visions to fruition. South Korea has great ambitions to become a G-7 nation by 2001 and an equal partner with the advanced countries. It plans to pave its path to advanced industrial status with information technology, fine chemicals, biotechnology, new materials, and aeronautics. Some Korean companies are now working in cutting edge technologies that were once the sole domain of advanced industrial nations. Samsung, a South Korean company, is now the world's largest maker of DRAMs, and Korea plans to spend $50 billion on an information superhighway.

Since 1980, the South Korean government has increased its R&D investment significantly. The science and technology budget has increased by 15 percent annually and jumped to over 30 percent in the 1996 budget. The Korean government plans to increase its R&D spending to over 4 percent of the GDP by 1998, and to 5 percent by the year 2000. Following the same trend, the Korean private sector has rapidly augmented its R&D investment by about 20 percent annually, encouraged in large part by government incentives. As a result, total R&D investment has increased from $418 million in 1981 to over $5.4 billion in 1995.

While one can certainly say that South Korea is just one country, and its resources and capabilities incomparable in size and scope to those of the U.S., Europe and Japan, all indicators suggest that there will be many such nations both crowding and expanding world markets, challenging traditional market leaders for a share. It is happening now. From 1994 to 1995, non-Japanese semiconductor suppliers in the Asia/Pacific region increased their world market share from 8.9 percent to 12.1 percent. The Europeans lost very little; instead, these gains came at the expense of Japan and North American countries.

In my view, policies designed to address the globalization of technology should seek to leverage a nation's interests in the global market place, but do so without impeding world business and growth. First, in the international arena, we need to agree on some reasonable rules of the game.

For example, the Trade Related Aspects of Intellectual Property (TRIPs) Agreement will raise the standards of protection given copyrights, trademarks, patents, industrial designs, semiconductor chip layout designs, and trade secrets in all of the countries that become members of the World Trade Organization. High-tech companies should be major beneficiaries. For instance, U.S. software vendors supply 75 percent of the $77 billion world market for packaged software. Yet it has been estimated that piracy deprived U.S. software developers of about $13 billion in worldwide revenues in 1993. U.S. vendors' future competitiveness depends most significantly on the level of protection of intellectual property rights worldwide.

The globalization of technology has brought many new opportunities for bilateral R&D cooperation and for multilateral cooperation. The precompetitive technologies developed jointly in such collaborations are clearly destined for commercial use and, thus, these arrangements must be carefully crafted to create the appropriate balance between cooperation and competition. The U.S. Commerce Department has worked hard to ensure adequate protection of intellectual property rights, and to develop frameworks that ensure balanced contributions and equitable benefits. The Intellectual Manufacturing Systems Program was ground-breaking in the development and testing of such a framework for multilateral cooperation, and we hope it will serve as a model for other international initiatives.

Second, nations must recognize that the globalization of technology has important implications for their domestic policies. For example, the U.S. Food and Drug Administration's product approval process and export regulatory requirements are critical issues affecting U.S. exports of medical equipment and supplies. This industry cites regulatory delays as one of the key reasons that U.S. manufacturers have relocated some of their production and R&D facilities overseas. Recent data show a significant

increase in overseas investment by medical device firms. Foreign direct investment capital outflows from the U.S. grew from an annual outflow of $333 million in 1989 to more than $1 billion in 1992.

Finally, with the globalization of capital, labor and technology, countries everywhere are striving to attract these engines of wealth creation to their shores, help them grow, and keep them within their borders. In the U.S., we have taken a number of measures to make our country a more attractive place to do business. For example, we are working toward deficit reduction and a balanced budget to free up capital for private sector investment. The recently passed telecommunications reforms will unleash a tidal wave of investment, creativity and new technology that will further buttress the U.S. lead in the Information Age. And the President and Vice President have championed the cause of modern infrastructure through the National Information Initiative, generating interest, excitement and investment across the nation.

Thus, global competition is taking place on two levels. First is the competition between companies. Second is the competition between nations to attract and retain the engines of wealth creation that increasingly skip around the globe looking for the best opportunities. This is a competition for investment capital, technology, business activity, and the jobs that come with them.

People around the world have recognized this competition between nations. For those nations who have little in the economic arena, the competition is perceived to be filled with opportunity and hope for the future. In contrast, for those nations that have had much, including the U.S., this competition has raised much anxiety. Yet we cannot turn back the clock and we cannot secede from the global competition. Our challenge is to prepare ourselves to seize the opportunities and create fertile ground for economic growth, with a healthy business climate, a modern infrastructure, and a world-class workforce.

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