APS NEWS

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celebrate a century of physics

Frist, Lieberman, Varmus Receive Y2K Public Service Awards

Photo credit: © 2000 Robert Visser

(Left to right) Awardees Senator Joseph Lieberman (D-CT), Dr. Harold Varmus, and Senator Bill Frist (R-TN).

On March 29th, Senator Bill Frist (R-TN), Senator Joseph Lieberman (D-CT), and Harold Varmus, former director of the National Institutes of Health (NIH) were awarded the first annual Public Service Awards on Capitol Hill, following a reception in their honor. The awards are jointly sponsored by the APS, the American Astronomical Society (AAS), and the American Mathematical Society (AMS), which collectively represent more than 100,000 scientists and mathematicians.

All three awardees have been instrumental in highlighting the interdependence of scientific disciplines and the need for a more balanced federal portfolio. Senators Frist and Lieberman were honored for their advocacy on behalf of increased federal investments in science and engineering research. They were among the original co-sponsors of the Federal Research Investment Act (S.296), which the Senate passed last year. The bill is currently awaiting House action. It would authorize doubling federal support of civilian science over the next decade. Now president of Memorial Sloan Kettering Cancer Center in New York, Varmus has been an outspoken promoter of all areas of science and oversaw an extraordinary five-year growth in the NIH budget during his term as director.

"At a time when public attention has been sharply focused on progress in medicine and information technology, these leaders have repeatedly stressed the importance of the basic sciences that have propelled the extraordinary advances in health care and economic prosperity," said APS Past President Jerome I. Friedman, who presented the award to Lieberman.

Frist graduated from Princeton University in 1974, specializing in health care policy at the Woodrow Wilson School of Public and International Affairs. He received his medical degree from Harvard Medical School in 1978 and spent several years in surgical training at Massachusetts General Hospital and Stanford University Medical Center. A former professor at Vanderbilt University Medical Center in Nashville, Frist is board-certified in both general and heart surgery. Elected to the Senate in 1994, he quickly established himself as an advocate of science, passing legislation to create the "Next Generation Internet" as well as the National Investment Act. "Research and development represent the cornerstone of our modernizing economy," he said in February 1999 in response to a strong presidential budget request for scientific R&D.

Now in his second term in the Senate, Lieberman has earned a national reputation as a thoughtful, effective legislator, winning kudos and endorsements from publications as diverse as the *New York Times*, the *New Republic* and the *New York Post*. Born in Stamford, CT, he received his bachelor's degree from Yale College in 1964, earning a law degree there three years later. He was elected to the Connecticut State Senate in 1970, serving 10 years. From 1982 to 1988 he served as Connecticut's attorney general and went on to win election to the U.S. Senate in an upset victory by just 10,000 votes. Re-elected six years later, he made history by winning the biggest landslide victory ever in a Connecticut race for a senate seat.

An Amherst undergraduate, Varmus earned a master's degree from Harvard University and his medical degree from Columbia University College of Physicians and Surgeons, interning at New York's Presbyterian Hospital. After two years as a clinical associate at the National Institute of Arthritis and Metabolic Diseases in Bethesda, MD, he spent much of his career at the University of California, San Francisco, beginning as a postdoctoral fellow in 1979. He was a co-recipient of the 1989 Nobel Prize for Physiology or Medicine with J. Michael Bishop.

Inside...

NEWS

OPINION

DEPARTMENTS

Physicists Urged To Rally in Support of Proposed Nanotechnology Initiative

In late 1959, Richard Feynman delivered one of his most famous lectures to a packed room at Caltech, entitled, "There's Plenty of Room at the Bottom." He spoke of a then-fledgling field of new physics at the atomic or nanometer scale, foreshadowing many of the research areas on the verge of fruition today: higher densities of information on scaled-down computers; the formation of micromachines (MEMS); the creation of designer materials; and the importance of biological techniques in controlling and manipulating matter at the atomic scale.

Forty years later, on January 21, 2000, President Clinton chose Caltech as the site to announce a bold new federal initiative on behalf of nanoscale science and technology. The FY2001 presidential budget request to Congress calls for a $227 million investment increase in nanoscale science and technology, for a total of $497 million.

The president's proposal is indicative of a growing awareness on the part of government that technology is a critical economic driver, according to Thomas Weber of the National Science Foundation, speaking at a special symposium at the APS March Meeting in Minneapolis. He pointed out that unlike similar past proposals, the strongest push for the nanotechnology initiative did not originate with the White House Office of Science and Technology, but with the president's National Economic Council. "The Administration realizes that much of the profitability and comforts we have in life, and our strong economy, is a direct result of research that was funded over the years," he said. "And they realize that if that standard of living is going to continue, the nation needs to invest right now so that the economy is still healthy 30 years from now."

Definitions of what constitutes nanotechnology are varied. Evelyn Hu (University of California, Santa Barbara) defined it as "the construction and utilization of functional structures and materials with at least one characteristic dimension at the nanometer scale." After 30 years of invigorating research, scientists now have the techniques and instrumentation required for nanoscale fabrication, and the application of nanotechnology to actual devices, such as quantum well lasers. But to fully realize its potential, Hu identified two critical issues: better control of critical dimensions and, in turn, microscopic properties of individual nanostructures; and the integration of those nanostructures into complex heirarchical systems, particularly through the use of such natural templates as molecular self-assembly.

Ever since Intel guru Gordon Moore made his now-famous observation in 1965 — that the number of transistors on a chip will double every 18 months — much discussion has centered on identifying the fundamental limits of Moore's Law. Invariably, such studies target a date roughly 10 years into the future, according to Robert Dynes (University of California, San Diego), for perfectly legiti-

Continued on page 7

CUNY Celebrates "Creating Copenhagen"

New York area physicists returned from the APS March Meeting just in time to witness two major physics events that took place on March 27 at the Graduate Center of the City University of New York (CUNY): a special opening of the APS Centennial Exhibit "To Advance and Diffuse the Knowledge of Physics" (see page 2), and an afternoon and evening symposium on the science and history of the relationship between Werner Heisenberg and Niels Bohr, coinciding with the New York premiere of the award-winning British drama *Copenhagen*. Full coverage of these events will appear in next month's *APS News*.

To Advance & Diffuse the Knowledge of Physics

100 Years of the American Physical Society

Excerpts from an exhibit displayed at the APS Centennial Meeting.

Curator: Sara Schechner, *Gnomon Research*
Exhibit Director: Barrett Ripin
With contributions by Harry Lustig, R. Mark Wilson, and others.

APS Today

As the world's largest physics association, the American Physical Society continues to serve the international physics community with journals, meetings, and public programs of the first rank.

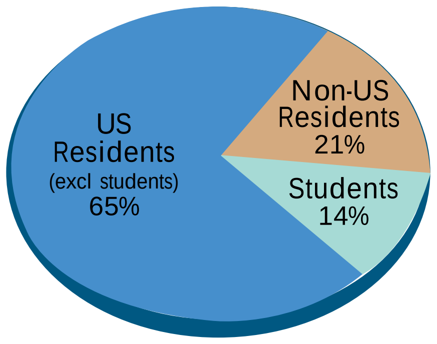
In 1997, APS members ratified a new, augmented mission statement:

> **In the firm belief that an understanding of the nature of the physical universe will be a benefit to all humanity, the objective of the Society shall be the advancement and diffusion of the knowledge of physics.**

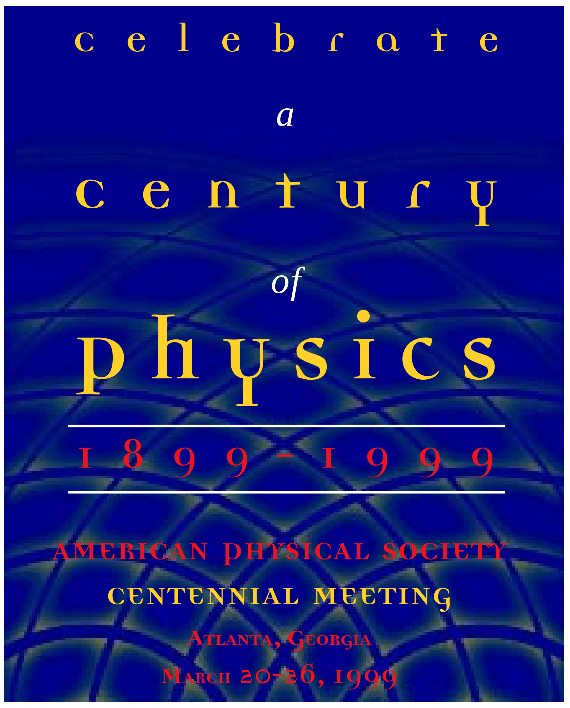
There is no doubt that the Society will keep on its august course in years to come.

The American Center for Physics, headquarters of the APS, located in College Park, Maryland.

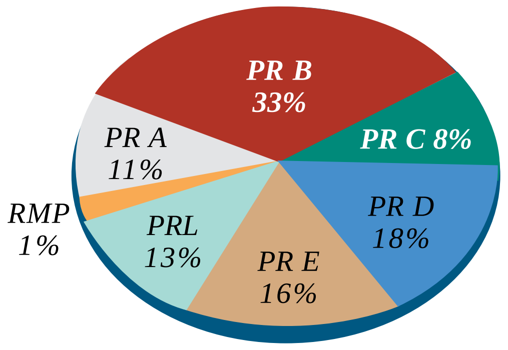
Membership: 42,622 World-Wide



- **93% PhDs** (excluding students)
- **Demographic Makeup**
  - 74% Physicists
  - 12% Engineers
  - 6% Female (13% age under 31)
- **Employment** (excluding students)
  - 47% Academia
  - 28% Industry, Consulting
  - 22% Government, FFRDCs



Journals: Over 93,000 *PR* & *PRL* Pages Published Annually



- **Over 22,000 Manuscripts Received**
- ***PR* and *PRL* Article Origins (1998)**
  - 36% North America
  - 38% Western Europe
  - 7.2% Japan (largest non-North American)
  - 6.3% Pacific Rim (excl. Japan)
  - 4.3% Eastern Europe
  - 3.9% Latin America
- **All APS Journals Are Online**
- **Online-Only APS Journals**
  - *PR Special Topics: Accelerators and Beams*
  - *PR Focus*

Speaking as much to members today as to our founders 100 years ago, Henry Rowland proclaimed:

> The study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race…Let us go forward, then, with confidence in the dignity of our pursuit. Let us hold our heads high with a pure conscience while we seek the truth, and may the American Physical Society do its share now and in generations yet to come in trying to unravel the great problem of the constitution and laws of the Universe.

Henry Rowland, *The Highest Aim of the Physicist*
APS presidential address, 1899.

Meetings: 12,000 BAPS Abstracts/Year

2 General Meetings (March and April)

8 to 10 Divisional/Topical Meetings plus 10 to 12 Sectional Meetings

Physics Outreach: $2.3 M/Year Expended

Education ✷ Public Information ✷ Government Affairs

International Relations ✷ Women and Minorities ✷ Career and Professional Development

Congratulations APS
101 years on 20 May 2000

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TREASURER'S REPORT

APS to Implement New Journal Pricing Policies

Thomas McIlrath, APS Treasurer

To Promote the Advancement and Diffusion of the Knowledge of Physics. That is the noble purpose of the American Physical Society, as stated in its charter of 1899. In pursuit of that goal, the Society publishes the world's premier physics journals; *Physical Review*, *Physical Review Letters*, and *Reviews of Modern Physics*. Over 13,000 articles in 90,000 pages were published in 1999. Over 1.6 million articles were downloaded from Physical Review Online in 1999. In order to make the literature available to everyone from their desktop anywhere in the world, the entire corpus of work published in APS journals since their beginning in 1893 is being placed in an online archive, PROLA, a project which will be complete early next year.

The Cost of Publishing and of Subscribing

Today the publishing of APS journals is a $26,000,000 business. Between 10% and 15% of that expenditure is for direct costs associated with mounting the journals online. PROLA has cost approximately $2,000,000 to date and will cost another $1,000,000 to complete the task of taking the archive back to 1893. Maintaining online access and updating PROLA are permanent expenses. Eliminating page charges in the 1990's shifted more costs onto libraries and today over eighty percent of the cost of producing and distributing journals is paid by library subscriptions. Libraries range from those serving the large national laboratories and research universities, to small liberal arts colleges. Over 60% of the libraries are located outside the United States. In the past, the need for multiple subscriptions to service the far flung staff of the large institutions meant that large research institutions supported a larger portion of the cost of the publication enterprise than the small colleges with a single subscriptions. The availability of online access has changed that. Now the largest research universities typically have the same number of subscriptions as the smallest schools, namely one subscription. Distribution to multiple departments and research groups is accomplished through the campus wide online access which accompanies the subscription to the journals. The result over the past decade is to shift the burden of support for distributing the results of physics research away from the large institutions onto the smaller ones.

Multi-tiered Pricing for Journals

To redress these changes in publishing the physics literature, and to return the balance of support for publication of physics research literature back towards its historic pattern, the APS will provide its journals to smaller, non-research oriented institutions at a lower price than that charged to research intensive institutions starting in 2001. The pricing will depend on the research activity of the institution as reflected in its Carnegie Classification. The Carnegie Foundation classifies U.S. academic institutions according to their size and research activity. The largest and most research active institutions are classified as Research institutions. Institutions providing doctoral degrees but with significantly lower research funding and doctoral production are categorized as Doctoral institutions. The remaining institutions include Masters, Bachelors, Technical schools, etc. (see http://www.carnegiefoundation.org). Starting in 2001 there will be separate pricing for each category.

Online-Only Access Options

In 2001 the APS journals will be available for the first time to institutions as an online-only option. The base price for the online journal, which is the price for all domestic academic institutions below the Carnegie Research or Doctoral classifications, will be 13% below the 2000 journal price. For Doctoral institutions the price will be 6% below the 2000 price and for Research Universities the 2001 price will be 2% above the 2000 price. CD-ROMs will be available at $50 per disc. The traditional option of print-plus-online will continue to be available. The lower cost of the online-only subscription reflects the savings from foregoing print production and delivery.

Pricing for Traditional Subscriptions

For those institutions which choose to continue their print-plus-online subscriptions, the price increases for 2001 versus 2000 will be 2% for base-price institutions, 11% for the Doctoral institutions and 20% for Research institutions. There will be no separately priced print-only subscriptions. With this new pricing, approximately two thirds of the subscribing institutions will see a 13% decrease (online only) or a 2% price increase (online plus print) in 2001. This is made possible by the larger price increase for the remaining institutions.

Classification of Foreign Institutions

There are no convenient classifications for foreign institutions. Therefore, foreign institutions will be placed into equivalent categories with domestic institutions, and charged accordingly, based on a comparison of their online usage with the median value of usage by the domestic Carnegie categories. Multi-tiered pricing is not an attempt to introduce usage based pricing. Rather, it is a move to put the larger burden for distribution of research information onto the research institutions. Online usage is only used to distinguish foreign institutions in an effort to obtain an objective identification of research intensive subscribers.

PROLA Online

It is recognized that the large price increases for the research organizations provides a real burden on tight library budgets. In order to provide a lower cost option to subscribers, the option of online-only access to the journal (no print copy) is being offered. As discussed above, this option provides a price reduction in 2001 for all subscribers below the Carnegie Research level. For the Research level institution it gives a 2% price increase in 2001. Foreign subscribers, paying air-freight costs, would see an even greater savings. The APS feels this will be an especially attractive option because of the availability of the Physical Review Online Archive (PROLA). PROLA currently contains all of the Physical Review from 1985 through 1996 (1997, 1998 and 1999 files are available on the current online journal platforms). By the end of 2000 the archive will contain Physical Review back to 1970, Physical Review Letters back to its beginning in 1958 and the Reviews of Modern Physics back to its beginning in 1929. Current plans call for all of the APS publications back to 1893 being in the archive by the end of 2001. PROLA will be continually updated to include all articles published more than three years before the current year. The more recent material will be on the current journal platforms. Negotiations are underway to maintain a fully current version of PROLA (including current issues) on several servers at institutional libraries to create a true archive. The maintenance of PROLA in a current and readily accessible form is a responsibility which the APS has assumed for the community. Access to PROLA is included in the price for the APS packages (PRALL and APSALL) and is available at a modest cost for subscribers of individual journals. The cost for PROLA covers maintenance of the archive and access to PROLA provides perpetual access to subscriber material.

Summary

There are tremendous pressures today on library budgets. The answer to that problem has to involve finding more efficient ways of distributing information. The APS strives to find the least expensive way of publishing the physics literature consistent with the highest standards of peer review publications. We cannot predict what the future will bring in terms of ultimate products and costs. It is inevitable that changes will occur in both the nature of the journals, as cost-cutting is implemented, and in the way costs are distributed among the diverse group of subscribers. We anticipate and welcome continued, spirited, discussions amongst the Society membership, the librarian community and other users as the changes evolve.

Remembering the APS-China Program

The death of Professor Xie Xide, on March 4, 2000, brought to mind her many contributions, and in particular, her key role in the "China Scholars Program" during the 1980s. This program, more formally known as the APS-China Cooperative Program in Atomic, Molecular, Laser and Condensed Matter Physics, had the goal of helping China to reestablish its physics community after the Cultural Revolution ended. Forty-eight bright young physicists spent approximately two years each in the US conducting research in university and industrial labs. As the lead person from China, Professor Xie committed herself to selecting only the most scientifically qualified physicists to participate in the Program. Now many of those who received advanced training in this Program hold distinguished positions in Chinese universities. Professor Xie was a tireless proponent of cooperation and collaboration between Chinese and American physicists, and throughout her life, she lost no opportunity to bring them together to their mutual benefit.

The Tiananmen crackdown of June 1989, which resulted in the APS canceling a meeting to celebrate a successful decade of cooperation, was a sad finale to the Program. The American Physical Society still feels a strong sense of accomplishment in helping to forge lasting links between Chinese and American physics, and helping China to develop its physics community. In this achievement Professor Xie, rightly deserves to be remembered as one of the most influential figures in forwarding the cause of international science.

— Benjamin Bederson

Editor's Note: Benjamin Bederson, formerly provost of NYU and editor-in-chief of the APS, was chair of the American Coordinating Committee for the APS-China Program, 1987-1991.

Librarians Speak Out

Editor's Note: *The following are selected comments from librarians at various research and educational institutions around the country, directed to APS Treasurer Thomas McIlrath in reaction to the new APS journal pricing plan. The responses are indicative of the Society's ongoing "spirited discussions" with this community regarding journal pricing and electronic publishing. All quotes are reprinted here with permission.*

"I fully support the new APS pricing structure. A 20% increase for research institutions seems eminently reasonable, given the large number of personal and institutional subscription cancellations over the past few years. Society publishers have long provided an exemplary model for the dissemination of scientific literature. Research libraries, in particular, should be sympathetic to their need to maintain a viable business model."

Dana L. Roth
California Institute of Technology

"There have to be better ways to disseminate science and technology information that don't entail the enormous amounts of money and inequitable distribution routes and rights currently owned by the publishers. Price increases like this make alternative publishing scenarios all the more attractive and I believe will only expedite their implementation."

Greg Youngen
University of Illinois, Urbana-Champaign

"I certainly have a lot of sympathy toward supporting smaller institutions, having recently come from one myself, and I think the *Physical Review* was pricing itself out of that market. I am glad the APS is remedying this situation. But I was under the impression this increase would be phased in gradually over the course of a few years, so there would not be a sticker shock from a one-time increase. A 20% increase for research institutions seems like a pretty big chunk to phase in all at once."

Michael Fosmire
Purdue University

"These scholarly society publishers have acknowledged the economic crisis we have reported, and are doing their best to find the thread to the future, while still offering the peer review process and taking responsibility for long-term archiving. It is my opinion that we need to work together, across fields, types of organizations or institutions, libraries, and across alternatives in attempting to influence the best future for our scientist-scholars."

Diane Fortner
University of California, Berkeley

OPINION

PRESIDENT'S CORNER

Media Outreach Programs Address Key Challenge

James Langer, APS President

Among the many new challenges facing the US physics community is the need to convince the public, and the Congress, of the excitement and importance of what we're doing. Physics no longer sells itself, nor can we count entirely on others such as teachers and journalists to build our image for us these days. It's our responsibility to make sure that young people understand how rewarding careers in science can be. And, like every other special interest group in our complex society, we now must make our own case for an adequate share of our country's resources. We make that case most directly by political advocacy in Washington, but our arguments cannot be convincing without the understanding and support of the voting public.

The APS has a strong record of public advocacy for physics. Bob Park, working out of our Washington office, has been outstandingly successful in publishing commentaries in major national newspapers and in television and radio interviews. His famous weekly email column, "What's New," is read with glee — and often chagrin — by scientists, politicians and bureaucrats throughout the country. More recently, the APS has hired Randy Atkins as a media-relations coordinator working in close collaboration with the AIP at our College Park headquarters. Randy's responsibility is to serve as a resource for newspaper and television reporters, directing their inquiries to knowledgeable scientists and alerting them about important developments in physics. He has been with APS for less than a year but already is having a major impact.

I realize that not all APS members feel comfortable about this new style of media-relations activity. Serious concerns were expressed, for example, at the APS Units Convocation in College Park last January. Some participants were worried that the media will get the physics wrong and make them look bad in the eyes of their colleagues. Or they fear that, even if the media do get it right and make them look good, their colleagues will accuse them of seeking personal publicity, publishing in the newspaper instead of going through the refereed journals. Many even fear that this peer-criticism will damage prospects for research funding.

Atkins tells me that he recently asked about the funding problem in a conversation with Bob Eisenstein, NSF Assistant Director for Mathematical and Physical Sciences. According to Bob, the fear that funding opportunities will be hurt by popularizing research is "not only wrong, but politically obtuse… We need to have an informed public that can make responsible judgements. At NSF, it's considered vitally important to get scientific information to the public. We would not penalize people who did this. On the contrary, we might give them a medal for it."

Why must we inform the public about our work? Because popular backing can, literally, mean life or death to scientific pursuits. The public needs to understand, not the particulars, but the broad significance of our work—its relation to technological progress, the quality of life, and an enriched understanding of our world. This is how science, whether funded by government or private enterprise, gets the resources that it needs to survive. Beyond funding, science must be made more accessible to the young people who will guide our future, and their parents who will guide them. Image may not be everything, but it sure helps with kids.

None of this is to say that it's OK to sacrifice scientific accuracy in talking to reporters or making public presentations. So how do we assure that that doesn't happen? One strategy is to ask journalists to allow us to check their stories for technical accuracy before publication, while assuring them that we won't get in the way of their editorial control. Let them know that we don't want to change wording—after all, they are the professional writers—we simply want to check for mistakes. Journalists don't want to look stupid.

But we have to understand that journalism is largely entertainment. People generally read the paper and watch TV during their leisure hours, when they're looking for fun rather than intellectual effort. So journalistic storytelling will never be as thorough as scientific writing. Remember too that, for journalists, space and time are precious commodities, not elegant physical concepts. Journalists must work within extremely tight constraints.

Finally, we must give our peers the benefit of the doubt when a story is reported inaccurately. Misstatements very likely are the fault of sloppy journalists, not inept scientists.

Even with inevitable imperfections, communicating science to the public is vital, and the media provide our most efficient vehicle for doing this. Public dialog has become, quite simply, a part of our jobs as scientists. We need to communicate science in media-savvy ways, showing especially its human side. The APS public-affairs experts unabashedly hope that some of us will become media stars. Those that reach that status may be unusual characters, with wit and charisma, because that's what interests people. Not all of us have such gifts, but we must appreciate those who do. Our APS media relations office is ready to help us play these roles—whether we're charismatic or not. Don't hesitate to contact Randy Atkins (301-209-3238; atkins@aps.org) for advice or comments.

Here, to conclude, is an excerpt from President Clinton's January 21 speech at Caltech:

"I have one other major mission here today. I want to take a step back, to acknowledge that we have not done a good enough job of helping all Americans understand why the enormous investments we are making in science and technology are so important. For far too many of our citizens, science is something done by men and women in white lab coats, behind closed doors—something that leads, somehow, to things like Dolly the sheep and satellite TV. It is our responsibility to help open the world of science to our citizens—to help them understand the great questions that science is seeking to answer, to help them see how those answers will directly affect their lives."

LETTERS

The Physics of Pynchon

I am responding to Robert A. Levy's challenge to consider the physics genealogy of Thomas Pynchon, the author best known for *Gravity's Rainbow* (*APS News*, February 2000). Personally, I have found reading Pynchon to be not unlike doing research. The Pivotal Moment in the narrative at which disparate plotlines and themes converge is just as likely to come in the midst of a long, parenthetical digression as in the main flow of things. It's important to pay close attention to everything, whether it seems to be part of the plot or just an interesting aside. It is not possible to skim Thomas Pynchon.

I would disagree with Levy's allegation that Pynchon is "long overlooked" by physicists whose "widespread ignorance" so alarms Levy. In my own reading, I have found Pynchon's work often brilliant, but frequently elliptical and pretentious. Yet there may be something about Pynchon that actually appeals to scientists. Perhaps it is the joy of loving something many others cannot quite grasp.

Thomas Pynchon knows physicists. He somehow, somewhere, learned about the pitfalls scientists face, and how we do our work. He picked up a lot of buzzwords and metaphors. (He must have had engaging, poetic teachers) But these metaphors must be pushed further, and their weaknesses exposed. It is my belief that the art in great physics (and great fiction) is in moving beyond the metaphor, in describing in a new way something so beautiful, or grotesque, or so perfectly ordinary, that no one has seen it exactly that way before—and those who already know its beauty, ferocity or truth will nod and say to themselves, "Yes, that's exactly right."

Jenn Stroud
University of California, Berkeley

Garwin's Objectivity Challenged

Richard Garwin's article in the February issue of *APS News*, "The Comprehensive Test Ban Treaty and US National Security", seems to have been packaged a bit deceptively. You identify him as an IBM Fellow Emeritus, etc. However, you neglect to mention that he is a well-known Democrat partisan, a consistent and vocal opponent of Republican policies or initiatives regardless of the scientific issues involved.

I was first exposed in person to his advocacy in the mid-80's, when he was an anti-SDI (Strategic Defense Initiative) crusader. This is not to say that he is not extremely smart or knowledgeable, or that his points do not have merit. But equally or even more talented physicists at the time recognized the potential of strategic defense without devoting their careers to political lobbying.

The same political correctness can be read in his article in your February issue. The text is virtually taken word-for-word from the Clinton administration playbook, as spun to the media during the vote on the test ban treaty. Thus, while cloaked in genuine science, it is a political document, dangerously suppressing valid science and policy issues. As many prominent and impartial experts testified during treaty hearings, there are genuine defects in the treaty as the Clinton administration submitted it to the Senate. But Garwin is not speaking as a scientist, as you would have us believe, impartially seeking the truth. He is speaking as a political partisan, bringing his great and convincing expertise and prestige to the job.

Laurence N. Wesson
Ambler, PA

Trans-Atlantic Support for CTBT

In the February 2000 issue of *APS News* Richard Garwin gives a very technical and persuave account to show that it is in the interest of the United States to sign the Comprehensive Test Ban Treaty (CTBT) if it wants to maintain an overwhelming superiority in Nuclear Weapons for an indefinite period of time. The question remains: is it indeed desirable for the United States to maintain an overwhelming superiority in Nuclear Weapons, or would the United States (and the rest of the world) be a safer place if one could get rid of all Nuclear Weapons. That is a much more complex issue and would require more than a letter But in the light of all this it appears more than difficult to believe that the U.S. can become a safer place by refusing to sign the CTBT. To use this issue as a political football seems outrageous indeed.

Henry A. Blumenfeld
Gif sur Yvette, France

Markowitz Statements Sadly Pessimistic

In his article on page 5 of the March 2000 issue, David Markowitz writes, "Sure, lots of folks believe in *God and family values* and few wish to argue against them. But *their main purpose* is what they earn for their promoters: money to do research on the one hand, and votes to propel them into office on the other (my italics)."

I wonder if the author realizes how sadly pessimistic his statement is? Finding meaning, purpose, and value in life through the love and grace of God and the bonds of family is fundamental to human happiness. This is true for the scientist, and statesman as well as regular people, whether or not they will acknowledge it. And to the degree that the general Judeo-Christian ethic of the latter has controlled the decision-making of the former, our democratic society has had a measure of justice and peace. Thus, it is a great blessing that everyone does not subscribe to the author's point-of-view.

I suggest that Dr. Markowitz read the book *How Should We Then Live* by Francis Schaeffer. It is a sobering, scholarly discussion of the effects of humanism on Western culture (on government, religion, science, philosophy, and the arts) beginning with the Renaissance/Reformation era. I think Dr. Schaeffer's work might do Dr. Markowitz (among others?) some good.

Barbara S. Helmkamp
Houston, Texas

Stretched to the Limit: Funding Shortfall Threatens Science Programs

By Judy Jackson; Fermi News; Volume 23, Number 6

Like a spring that can be stretched only so far and still bounce back, the U.S. High Energy Physics program has reached the limit of budget stretching before irrevocable changes threaten its capacity for world-leading science. That was the message that members of the Department of Energy's High Energy Physics Advisory Panel heard from speaker after speaker at HEPAP's spring meeting, held at Fermilab on March 9 and 10.

Paradoxically, at a time when long-straitened budgets for basic science in the United States are facing the best funding prospects in many years, the budgets for high-energy physics laboratories, already eroded by a decade of inflationary effects, took a downturn in the President's Budget Request for Fiscal Year 2001. The situation is particularly troubling, DOE and laboratory officials told the panel, because both Fermilab and SLAC are poised to begin using brand-new, multimillion-dollar facilities to carry out physics experiments whose potential for discovery is unsurpassed in the world.

"We have a fifty million dollar problem," said DOE's John O'Fallon, director of the Division of High Energy Physics. "In FY2001, Fermilab has a $33 million problem and SLAC has a $15 million problem. Now, we have to fix it."

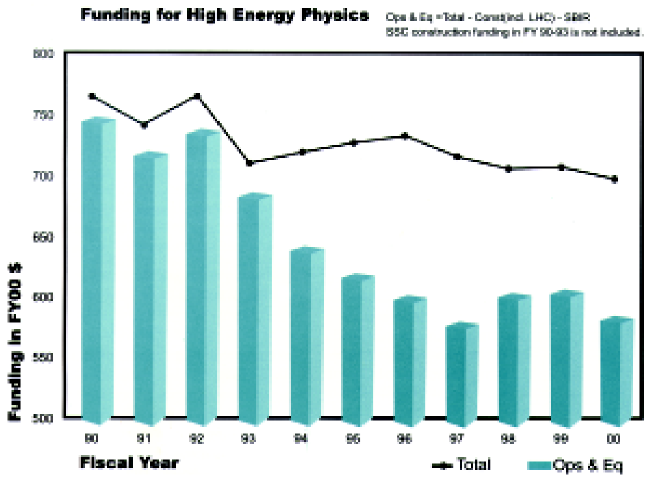
O'Fallon, Fermilab Director Michael Witherell and SLAC Director Jonathan Dorfan all showed HEPAP members the same graphic illustration of the course of high-energy physics funding over the past decade.

The chart, which appears at right, shows a $180 million decline in annual funding for operations and equipment for high-energy physics at DOE from 1990 until the present year, using current-year dollars and totals supplied by DOE's Division of High-Energy Physics. These are the funds required to utilize the investment in physics facilities. Fermilab's Witherell explained that the inflation index used to calculate yearly levels almost certainly underestimates the real inflation rate that high-tech organizations have typically faced in recent years. The "Operations and Equipment" line results from subtracting construction funds, including funding for the U.S. contribution to the Large Hadron Collider at CERN, from the total. The low level of construction funding in the years 1990-1993 occurred because the construction funding for the Superconducting Super Collider laboratory, now terminated, is not included in the total.

Laboratory presentations from the Fermilab and SLAC directors emphasized the extraordinary physics opportunities made possible by major U.S. investments in new physics facilities, especially Fermilab's Main Injector and SLAC's B Factory.

Witherell described progress on the NuMI/MINOS project, which will send a high-intensity beam of neutrinos from Fermilab's Main Injector to a particle detector in northern Minnesota to search for evidence of oscillation from one neutrino flavor to another. He said the neutrino experiment was "the most sensitive" to the impact of proposed FY2001 funding cuts, and that the resulting delay "would significantly reduce the impact of the experiments."

SLAC's Dorfan told panel members of the excellent performance of the laboratory's new B Factory and BaBar detector, whose current physics run began in mid-January, 2000, and will continue through August. He said SLAC has set an ambitious luminosity goal of 12 inverse femtobarns, to break new ground in the understanding of the matterantimatter asymmetry known as CP violation.



Funding Crisis Ahead

"If we don't improve the budget for FY200l," Dorfan said, "something will be irrevocably reset in this field. You don't recover from something like this in a year. Congress funded the B Factory at SLAC and the Main Injector at Fermilab. They did their job. And we did our job: we built them on time and on budget. Now we are ready to use them. Congress doesn't want to throw that away."

"We have successfully completed accelerator upgrade projects that renewed our research program without a very large new accelerator facility," Witherell said. "We are now trying to take advantage of the scientific opportunities made available by the new accelerator complexes, but the funding level is not sufficient to do that."

Between a 20 percent cut in the base budget for the laboratories since 1992 and a five-plus percent inflation rate, driven by rising salaries for valuable scientific and technical staff, the laboratories are in real trouble, Witherell said.

"The staffs are too thin to operate the facilities, build the experiments and prepare for the future. Scheduled projects are not getting the funding they need to stay on schedule. The funding at SLAC is bad. The budget at Fermilab is even worse, worse than at any time in memory," he said.

As one way to address the overall funding challenge, DOE's Peter Rosen, Associate Director for High Energy and Nuclear Physics, requested that HEPAP review the 1997 Gilman Subpanel "Report on the Future of High-Energy Physics" and provide updated interim guidance on the direction of the field.

"Some think that the high-energy physics community has no clear idea where it's going," Rosen said. "We must formulate a national plan, with expenditures, timelines and road maps for the three proposed new facilities at the energy frontier and for the muon storage ring at the intensity frontier. This is an important step in developing an adequate budget."

Spallation Neutron Source Features Superconducting Linac

One of the three accelerators making up the linac at the Spallation Neutron Source, now under construction at Oak Ridge National Laboratory, will consist of superconducting niobium rf cavities, cooled with liquid helium to an operating temperature of 2K. This part of the linac will perform the final stage of acceleration of the negative ions, from about 200 MeV to 1 GeV. Superconducting rf technology is expected to be the technology of choice for many future accelerators, and will enhance the capabilities and longevity of the SNS.

Construction of the Spallation Neutron Source (SNS) facility began on December 15, 1999, with groundbreaking at the Oak Ridge, Tennessee site. At a cost of $1.4B, the SNS is scheduled for completion in 2006. The project is funded by the U.S. Department of Energy (DOE) Office of Science and is being designed and constructed by a partnership of six DOE national laboratories (Argonne, Brookhaven, Jefferson, Lawrence Berkeley, Los Alamos, and Oak Ridge), which is unique for such a large-scale facility. When the SNS is complete, it will be the most powerful pulsed neutron source in the world. As such it will provide research opportunities unavailable elsewhere.

Although the United States pioneered the development and use of early neutron sources, European and Japanese scientists developed newer sources that have been the best in the world for the past 15 to 20 years. Since the1968 start-up of the Institut Laue Langevin in France, Europe has been the leader in neutron-scattering research. In scientific terms, however, even the newest existing facilities are quite old. With the construction of the SNS, that situation is about to change.

The SNS design calls for an accelerator system consisting of an ion source, a 1-GeV linear accelerator, and a proton accumulator ring that will deliver a 2-MW beam to a liquid mercury target. A prototype negative hydrogen (H^-) ion source has already been tested.

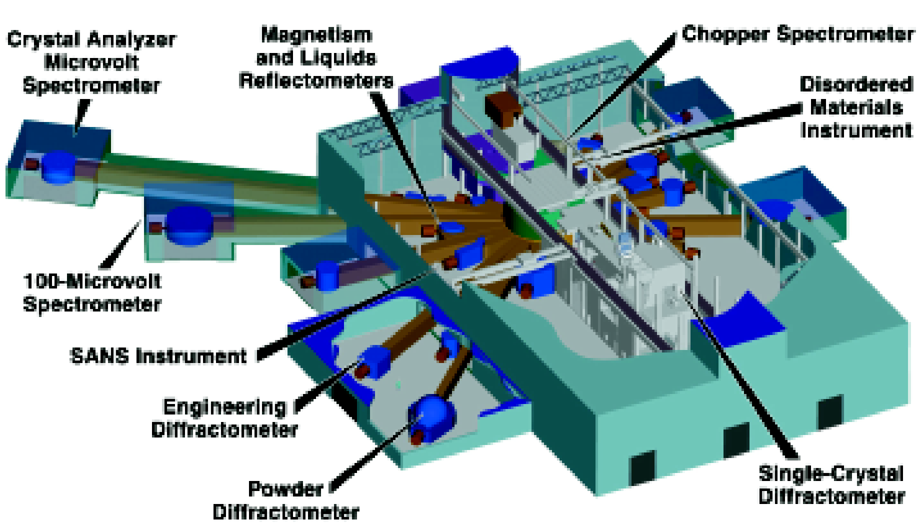
Three different types of accelerators will be employed in the linac. The superconducting linac described above is preceded by a drift-tube linac and a coupled-cavity linac, which are made of copper and operate at room temperature. To produce the short, sharp pulse of neutrons needed for optimal neutron-scattering research, the H^- beam from the linac must be compressed more than 1000 times.

Because of the enormous power the 1-GeV proton beam will deposit in the target, a liquid mercury target will be used instead of a solid material such as tantalum or tungsten. The SNS will be the first scientific facility to use mercury as a target for a proton beam. Cryogenic moderators will be located above and below the target, and one ambient moderator will be located below the target.

An opportunity for future development will be a second target station dedicated to the use of long-wavelength neutrons provided with a longer pulse separation (i.e., a lower pulse rate) than in the first station. The SNS is working with the National Science Foundation to explore avenues by which their grantees could participate in the SNS project by developing this future target station and its associated instrumentation.

SNS Instrumentation

When SNS is complete and operating at 2 MW, it will offer more than an order-of-magnitude higher flux than any existing facility, with potential for research in chemistry, condensed matter physics, materials science and engineering, and biology. A world-class suite of instruments is being developed that is suited to the needs of users across a broad range of disciplines.



Schematic instrument suite for the SNS. Already on the drawing board are the crystal analyzer microvolt spectrometer (top left) and magnetism and liquids reflectometers (top middle). The final instrumentation will be determined by the user community through the SNS Instrument Oversight Committee.

The SNS will be a user facility, and the scientific user community has been heavily involved in establishing performance requirements for the SNS and in selecting the initial instruments to be included in the facility. The current instrumentation budget allows for 10 or 11 best-in-class neutron-scattering instruments out of a total of 24, which can ultimately be accommodated on the high-power target station. The SNS construction budget for instruments is supplemented by a significant R&D program.

The main criteria for instrument selection are the scientific program articulated by the instrument team and the need for the unique capabilities of the SNS. The goal is seamless user access and instrument optimization across the facility. Plans are in place to obtain input at the Users Meeting and Instrumentation Workshop to be held May 22–24 in Washington, D.C. Additional information about the conference or comments and suggestions regarding the instrument suite may be directed to the SNS Experimental Facilities Division Director, Dr. Thom Mason (masont@ornl.gov) or the SNS Instrument Systems Team Leader, Dr. Kent Crawford (rkcrawford@anl.gov).

The SNS is at a critical stage as it emerges from conceptual design and begins physical construction. Endorsement by the Solid State Sciences Committee of the National Research Council and the recent resolution of support from the Council of the American Physical Society have both stressed the national importance of the SNS. More information on SNS is available from the SNS web site at http://www.ornl.gov/sns/.

Out of Africa: Using Fractals to Teach At-Risk Students

Fractal geometry is broadly evident throughout traditional African culture, according to Ron Eglash, an assistant professor of science and technology studies at Rensselaer Polytechnic Institute (RPI) in Troy, New York. He has documented fractal patterns in corn-row hairstyles, weavings and architecture of African villages, as well as in Santeria, the traditional religion of West Africa's Yoruba people and many forms of traditional African art. His research led to the publication last year of a book entitled, *African Fractals: Modern Computing and Indigenous Design* (Rutgers University Press, 1999).

Eglash completed an undergraduate degree in cybernetics and a master's degree in engineering at the University of California, Los Angeles and worked for a year at National Semiconductor on intelligent interface design. Intrigued by the prospect of gaining a more cultural perspective on what he terms "technosocial systems," he entered the History of Consciousness doctoral program at the University of California, Santa Cruz. "It had a reputation for allowing students the freedom to create their own interdisciplinary combination of courses," he says. "I was able to take classes in anthropology and graduate seminars in mathematics, and also work on computing models."

After completing his PhD, Eglash won a Fulbright scholarship and chose to do fieldwork in West and Central Africa. "I was looking for something that would combine both my technical and cultural interests," he says, and serendipitously came across an article on the relation between housing and women's autonomy in Tanzania. Traditional African settlements are self-organized, creating a self-similar, or fractal, structure, which provided greater social control for women, but the onset of modernization programs brought more rigidly structured cartesian grids to the village housing design.

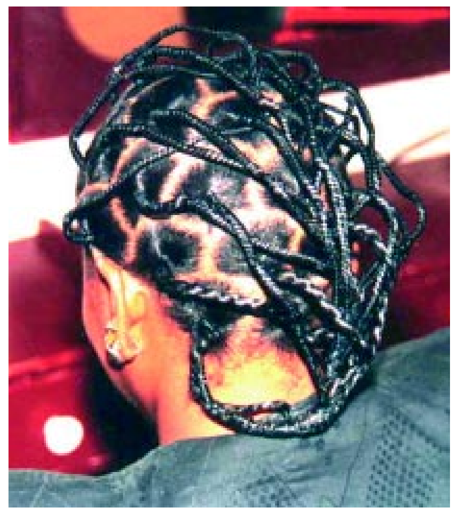


Photo credit: Ron Eglash

A fractal branching pattern, "la tress de fils," in the hairstyle of a woman in Yaounde, Cameroon. The corresponding simulation can be found at http://www.rpi.edu/~eglash/eglash.dir/afmulti.htm

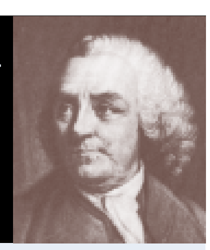
"That got me thinking about the fractal/Euclidean contrast and I began studying aerial photos of indigenous architectures," says Eglash. When he scanned the photographs into the computer and analyzed them mathematically, he found that they were fractal in nature — and many, although not all, were based on explicit geometric algorithms. He also found numeric systems which employed recursion, similar to the pseudo-random number generation in computers. Nor are these fractal patterns characteristic of all indigenous layouts: a similar analysis of Native American and South Pacific villages did not reveal a fractal structure, making it a design theme culturally specific to Africa.

Eglash believes that such design themes could indicate that traditional African mathematics may be much more complicated than previously thought. In fact, his discovery could prove to be an effective teaching tool for instructing African-American students about their mathematical heritage. It might also lead to a novel approach to integrating information technology with Third World development. To increase awareness of his discovery among educators, he routinely speaks about his work with African fractal patterns at the annual meetings of the National Council of Teachers of Mathematics, and several teachers have reported positive results from using the material with their students. More recently he began to work with a local organization in Troy known as "The Ark", which sponsors educational programs for at-risk African-American students. His Web site features an interactive Java simulation that enables students to explore scaling models with relation to corn-row hairstyles, and he hopes to eventually create a CD-ROM math lab incorporating his fractal material.

Employing African fractal patterns and other forms of indigenous mathematical practices in the classroom could help offset a long-standing over-emphasis in the US on biological determinism, which Eglash believes creates a learning deterrent for students of all ethnic groups, including white students. He notes that certain cross-cultural studies revealed that while children, teachers and parents in China and Japan tend to view difficulty with math as a problem of time and effort, their American counterparts attribute differences in math performance to innate ability — which then becomes a self-fulfilling prophecy. "We need to be open-minded about the different ways in which different students can improve their mathematical performance, and find out how to accommodate those differences in the classroom," he says.

Read more about African fractal patterns and sample the new software at Ron Eglash's home page: http://www.rpi.edu/~eglash/eglash.htm

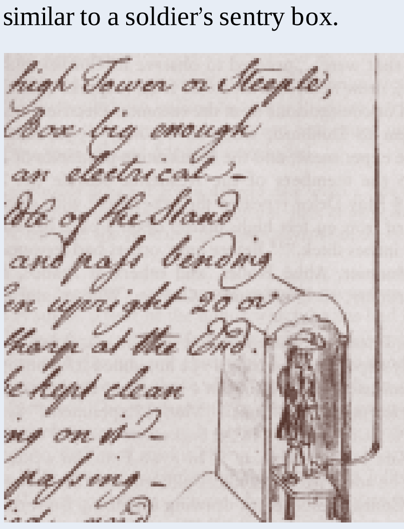
This Month in Physics History



First Experiment to Draw Electricity from Lightning, May 10, 1752

American school children of all ages are familiar with the story of Benjamin Franklin and his famous experiment to determine if lightning was in fact an electrical current: attaching a metal key to a kite during a thunderstorm to see if the lightning would pass through the metal. But contrary to popular belief, Franklin wasn't the first to successfully conduct this pivotal experiment.

A self-educated, amateur scientist, Franklin was fascinated by the so-called "electric fluid," and independently investigated charged objects and how sparks jumped between them using an electricity tube given to him by his friend Peter Collinson. He concluded that lightning was merely a massive electric spark, similar to those produced from charged Leyden jars. Based on his observations, he proposed an experiment with an elevated rod or wire to "draw down the electric fire" from a cloud, with the experimenter standing in the protection of an enclosure similar to a soldier's sentry box.



AIP Niels Bohr Library

Franklin's sentry box experiment.

Before Franklin could put his proposal into practice, Frenchman Thomas Francois D'Alibard used a 50-foot long vertical rod to draw down the "electric fluid" of the lightning in Paris on May 10, 1752. One week later, M. Delor repeated the experiment in Paris, followed in July by an Englishman, John Canton. But one unfortunate physicist did not fare so well. Georg Wilhelm Reichmann attempted to reproduce the experiment, according to Franklin's instructions, standing inside a room. A glowing ball of charge traveled down the string, jumped to his forehead and killed him instantly — providing history with the first documented example of ball lightning in the process. To add insult to injury, Russian chemist Mikhail Lomonosov successfully performed the same experiment a few days later.

As for Franklin, he was apparently unaware of these other experiments when he undertook his own version during a thunderstorm in June 1752, on the outskirts of Philadelphia. Unlike Reichmann, he quite sensibly stood under a shed roof to ensure he was holding a dry, non-conducting portion of the kite string. Impressed with lightning's power and potential danger, he went on to develop the lightning rod as a protective measure, as well as a device called "lightning bells" that would jingle when lightning was in the air. His observations laid the groundwork for later scientists, including Michael Faraday and Thomas Edison, to further explore the mysterious properties of electricity.

Birthdays for May:

11 Richard Feynman (1918)
15 Pierre Curie (1859)
21 Andrei Sakharov (1921)
23 John Bardeen (1908)

MEETING BRIEFS

Texas Section, March 9 - 11, College Station, TX

The APS Texas Section held its annual spring meeting in March at Texas A&M University, in conjunction with the corresponding regional section of the American Association of Physics Teachers. The meeting featured general sessions on frontiers of physics and innovations in physics teaching, as well as an extensive program of hands-on workshops for physics teachers and tours of physics research facilities. Friday morning's lectures opened with a review of high school physics texts by Clifford Swartz, editor of *The Physics Teacher*. He was followed by two talks on the accelerating expansion of the universe by Wendy Freedman (Carnegie Observatory) and Robert Kirshner (Harvard-Smithsonian Center for Astrophysics). AAPT Past President Joel P. Meyer spoke at Friday evening's banquet, demonstrating the joys of physics demonstrations. On Saturday, Dan Bruton and Stephen Austin of Texas State University spoke on the search for minor planets.

New York State Section, April 7 - 8, Corning, NY

The APS New York State Section held its annual spring meeting at Corning Community College in April, in conjunction with the corresponding regional section of the American Association of Physics Teachers. The selected theme was the tools, research and theory of astrophysics, chosen because of the on-campus availability of a working model of the Palomar telescope, as well as the proximity of Corning Inc., a company long involved with the production of large telescopes. Virginia Trimble (University of California, Irvine) was the featured speaker at Friday evening's banquet. Session speakers included James Houck of Cornell University, who spoke on SIRTF, which he considers to be the last of the great observatories, as well as Alfred Mann and Douglas Cowen, both from the University of Pennsylvania, and Cornell's Ira Wasserman. The meeting closed with a "make and take" physics teaching workshop,

New England Section, April 14 - 15, Providence, RI

The APS New England Section held its annual spring meeting in April at Rhode Island College in Providence. Friday afternoon featured a physics of toys "make and take" workshop, demonstrating how teachers can construct their own materials for use in their physics classes. Running in parallel was an APS session on physics, industry and society, featuring lectures by Michael Lubell of the APS Washington Office on science policy for the new millennium, and Peter Mumola of Zygo Corporation on academic/industry relations. At Friday evening's banquet, John Stachel of Boston University gave the after-dinner address, entitled, "Einstein: A Man for the Millennium?" Saturday morning's plenary session focused on physics teaching. Wolfgang Christian (Davidson College) is a leader in the development of computer-based interactive material for classroom use. He described his development of "physlets," a series of JAVA applets designed to be used in many different browser contexts. Howard Goldick of the University of Hartford described how he has developed courses to teach physics to physical and occupational therapy students, drawing examples from the human body to illustrate such common physics concepts as vectors, conservation of energy, heat transfer, voltage and capacitance. The meeting also featured a lecture by George Gibson (University of Connecticut) on teaching the physics of music, as well as a special roundtable discussion on how to pique students' interest in science.

Announcements

APS UNDERGRADUATE PHYSICS STUDENT COMPETITION

2000 APKER AWARDS

For Outstanding Undergraduate Student Research in Physics

Endowed by Jean Dickey Apker, in memory of LeRoy Apker

DESCRIPTION

Two awards are normally made each year: One to a student attending an institution offering a Physics PhD and one to a student attending an institution not offering a Physics PhD

- Recipients receive a $5,000 award; finalists $2,000. They also receive an allowance for travel to the Award presentation.
- Recipients' and finalists' home institutions receive $5,000 and $1,000, respectively, to support undergraduate research.
- Recipients, finalists and their home physics departments will be presented with plaques or certificates of achievement. The student's home institution is prominently featured on all awards and news stories of the competition.
- Each nominee will be granted a free APS Student Membership for one year upon receipt of their completed application.

FURTHER INFORMATION

(See **http://www.aps.org/praw/apker/descrip.html**)

DEADLINE

Send name of proposed candidate and supporting information by **16 June 2000** to:

Dr. Alan Chodos, Administrator, Apker Award Selection Committee
The American Physical Society, One Physics Ellipse, College Park, MD 20740
Telephone: (301) 209-3268, Fax: (301) 209-3652, email: chodos@aps.org

SEARCH FOR EDITOR, JOURNAL OF APPLIED PHYSICS

The American Institute of Physics is seeking an Editor for the Journal of Applied Physics to succeed the current Editor Steven Rothman, who intends to step down from his post in December 2000. Candidates should be well-respected scientists in applied physics, and should have the abilities and devotion necessary to advance the Journal's reputation of excellence. The Editor will be eligible for an honorarium or compensatory payment to his or her institution. Please send applications or nominations (preferably by email) before May 31, 2000 to:

Dr. Jerry Meyer
Chair, JAP Search Committee
Naval Research Laboratory
Code 5613
4555 Overlook Avenue, SW
Washington, DC 20375
EMAIL: meyer@sisyphus.nrl.navy.mil

Nanotechnology Initiative, *continued from page 1*

mate reasons. (The current cutoff point is expected to be reached by 2010.) "But the curve just keeps crashing right through them," he said. The reason is that scientists keep coming up with new materials, algorithms, architectures, and other innovative ways to overcome past technological barriers. "I allege that Moore's Law will continue as long as the scientific and engineering community remains healthy," said Dynes. "But if we do not continue to function as an intelligent, creative society, Moore's Law will be limited."

Unfortunately, Dynes has observed some worrying signs that the future is not necessarily bright for science and engineering. While the life sciences have flourished since 1970, federal funding levels for engineering and the physical sciences have been relatively flat. More worrisome is the impact these funding trends are having on the number of students earning degrees in engineering and the physical sciences: in fact, the latter ranks near the bottom of degrees received in the U.S., just above home economics and parks, recreation and leisure. "These young people are our feedstock," he said. "These are the creative people that we hope will fuel the future of nanotechnology, and they're not going into physical science and engineering."

Patricia Dehmer, who spent many years as a high-level researcher at Argonne National Laboratory before joining the Department of Energy, stressed to the audience that the initiative faces a very tough battle in Congress. Hence the scientific community must communicate with their Congressional representatives if the initiative is to survive — a point that was echoed by each of her fellow speakers. She pointed out that past initiatives had failed simply because "there was no 'buzz' on the Hill," and cited the success of the National Institutes of Health, whose budget has increased $4 billion over the last few years — more than the total funding for the NSF. Its success is largely due to its extraordinarily competent and powerful lobbying organization and substantial grass roots activity by NIH members. In contrast, Michael Lubell, APS director of public affairs, reported that less than 500 of the 43,000 APS members have regular contact with Congress.

"The Nanotechnology Initiative will enable the scientific community and our country at large to take advantage of the tremendous potential of nanoscale science and technology across a broad spectrum of basic and applied research," said APS President James Langer, who chaired the symposium. "But it's still a proposal, and it's not the responsibility of the government, but of the scientific community as a whole to help the nation understand the importance of this proposed initiative."

New E-Mail Network on Missile Defense Issue

President Clinton is expected to decide this summer or fall whether the United States should begin deploying a National Missile Defense system intended to protect all 50 states from a limited attack by some tens of long-range ballistic missiles armed with nuclear, biological or chemical warheads. Such attacks are envisaged to include: a deliberate attack by "emerging missile states" such as North Korea, Iran and Iraq, that might acquire such a capability in the future; or an accidental, unauthorized or erroneous attack by Russia; or an attack by China.

We wish to draw the attention of APS members to a new e-mail network for scientists who wish to become engaged in this issue. To learn more about this activity, please email: armsnet@ucsusa.org.

Richard L. Garwin
Council on Foreign Relations, New York

Kurt Gottfried
Cornell University; Ithaca, NY

APS MATCHING MEMBERSHIP PROGRAM

Relief is at hand for physicists living in developing and hard-currency-poor countries through the APS Matching Membership program. Established in 1983, the program allows individuals residing in eligible countries — especially those who are members of their national physical societies — to apply for a reduced-cost APS membership. Membership is available in one of two categories, with the associated benefits of each outlined below:

- A half-price membership at $45 is available for those with an individual or institution willing to co-sponsor them and provide payment. Members at this level can subscribe to a maximum of one (1) journal at member rates and register for APS meetings at member rates. They will also receive *APS News* and *Physics Today*.
- A graduated, reduced-cost membership beginning at 20% of the full membership rate in the first year is available to individuals on a limited basis. Applicants who are unable to pay and who do not have a sponsor may request APS support. Members in this category will receive *APS News* and *Physics Today* and may register for APS meetings at member rates. No journal privileges are included, but members who have difficulty accessing APS journals may apply to the APS Office of International Affairs to enroll their institutional libraries in the APS Journal Outreach Program. In each of the next three (3) years, membership dues will increase by 10%. Upon reaching 50% in the fourth year, a maximum of one (1) journal is available at member rates.

Membership will be renewed on a yearly basis via invoice. Each member sponsored through this program may participate for no more than six (6) years in order to accommodate as many physicists as possible. At the completion of the six-year term, all participants will be billed at full member rates. Enrollment is limited to 1.5% of the current APS membership level. Thus, in 2000, the program can accommodate 640 participants.

We encourage the physical societies and institutes with which we share reciprocity to inform their members of this beneficial program. We emphasize that membership in the applicant's national society is desirable to strengthen the association between the APS and its Reciprocal Member Societies.

For further information about the APS Matching Membership Program, please contact the Membership Department at (301) 209-3280 or membership@aps.org

Living in a Nano-Scale World

A sampling of nanotechnology-related research presented at APS March Meeting

- **A Billion Calls in the Palm of Your Hand**. David Bishop of Lucent Technologies/ Bell Laboratories has developed a MEMS-based optical switch, part of Bell Labs' efforts in developing a new class of extremely small optical devices; smaller than grains of sand. Essentially a microchip covered with tiny steerable mirrors, the device is small enough to fit in the palm of your hand and yet capable of routing a billion telephone calls. The by-now well-worn Moore's Law stipulates that the density of electronic components on a silicon chip doubles every 18 months; for photonics, the doubling occurs every nine months.
- **Magnetic Storage**. Researchers at IBM research centers have combined nanotechnology with chemistry to create a radically new class of magnetic materials that may one day allow computer hard disks and other data storage systems to store more than 100 times more data than today's products. The materials are based on chemical reactions that cause tiny ferromagnetic particles — only 4 nanometers in diameter — to self-assemble into well-ordered arrays. The reactions also permit precise control of both the size of the nanoparticles and their separation distance, factors that are critical in increasing data density.
- **DNA Electronics**. DNA molecules code the architecture and function of cells in living organisms. But strands of DNA are also handy props for scientists and engineers to use in designing electronic products, including biosensors, because of their ability to self-assemble and to recognize sequences of base pairs. For example, Erez Braun and colleagues at the Technion-Israel Institute of Technology have developed a method for self-assembly of junctions of molecule-scale wires based on DNA. Such junctions are necessary in the formation of molecular transistors and circuits. Only 15 nanometers across, the wires are three times smaller than the smallest wires thought to be achievable in the future with conventional silicon transistors.
- **Carbon Nanotubes**. According to Cees Dekker of the Delft University of Technology in the Netherlands, carbon nanotubes may become an important component of molecular electronics because of their robustness and versatility. Nanotubes are long cylindrical all-carbon molecules with unprecedented electrical and mechanical properties. STM on single-wall nanotubes have shown that they are either semiconducting or metallic. Experiments on semiconducting nanotubes show that we can build a single-molecule field-effect transistor that operates at room temperature. Transport studies on samples with low-ohmic contacts show that nanotubes can sustain very high current densities, while kinks can act as junctions.

–Compiled with the assistance of Philip Schewe/Ben Stein; AIP Public Information

THE BACK PAGE

Top Twenty Technological Screw-ups of the 20th Century

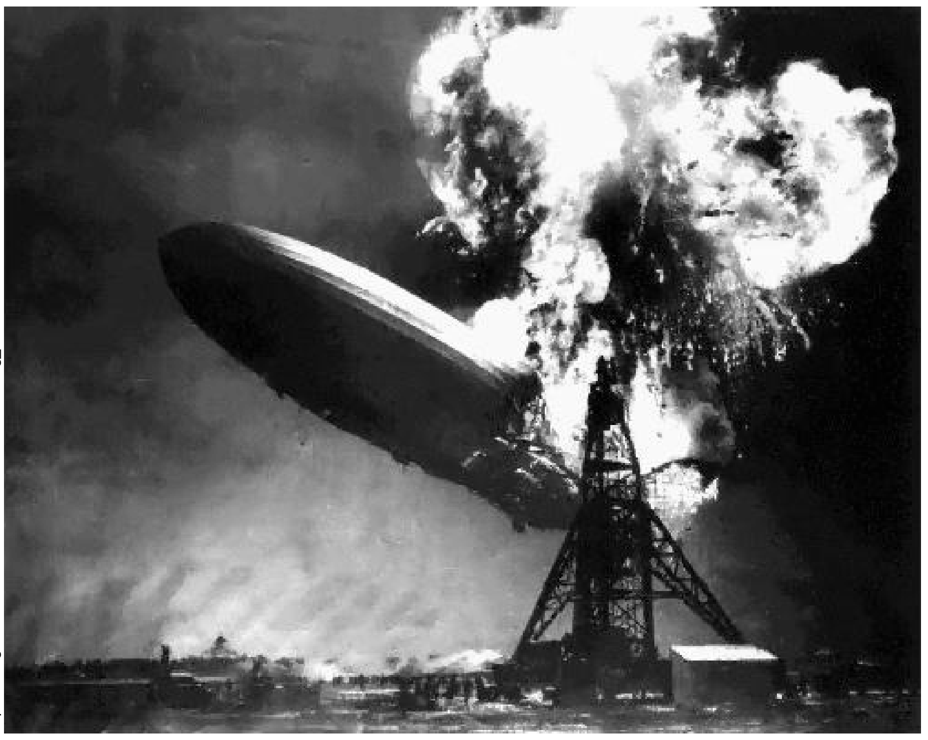
By Marc Abraham

Selected by the Ig Nobel Board of Governors

Commissioned by Wired News and the Annals of Improbable Research

In a century crammed to bursting with screw-ups, a century that gave birth to Murphy's Law ("If anything can go wrong, it will."), it is difficult to choose a mere twenty outstanding screw-ups. Inevitably and unfairly, several hundred thousand worthy achievements were left out. We chose for style and symbolic value, as well as for substance or lack thereof. We kept in mind that technology is a combination of things, techniques, and the people who devise, make, and use them.

The people mentioned here had reasons — in many cases very good reasons — for doing what they did. (In at least one case, that of Corrigan, some contend that the entire screw-up was cleverly planned as such.) These screw-ups can serve as fodder for thought, argument, or pure, unabashed wonder.



http://www.geocities.com/Area51/Zone/5942/hindenburg_index.html

Screw-up #4: Successful demonstration of the flammability of gaseous hydrogen.

1 In 1903, physicist Rene Prosper Blondlot of the University of Nancy, France, announced a great scientific discovery: a new kind of radiation called "N-rays." X-rays had been discovered just a few years earlier, causing worldwide excitement, and Blondlot's N-ray announcement caused a sensation. After seeing a demonstration of Blondlot's N-ray detector, American physicist R.W. Wood secretly removed the guts from the machine and then asked Blondlot to repeat the demo. Blondlot, using the broken machine, insisted that he was still seeing N-rays. Almost everyone except Blondlot then concluded that N-rays do not exist. This became the science community's great example of why extraordinary claims ought to be tested before people accept them as valid.

2 On April 14, 1912, the ocean liner Titanic, described by its manufacturers as unsinkable, sank on her maiden voyage.

3 During World War I, nearly all the world's technological innovation was poured into the battlefields of Europe's Western Front. Both sides expected their technology would quickly break the impasse. Instead, it produced three years of deadlocked trench, barbed wire, rifle, grenade, machine gun, artillery, gas, tank, and aeroplane warfare, and the deaths of millions of people.

4 On May 6, 1937, the hydrogen-filled dirigible Hindenburg, arriving in Lakehurst, New Jersey, after a transatlantic flight, caught fire and disintegrated.

5 On July 17, 1938, pioneer aviator Douglas (ever after to be called"Wrong Way") Corrigan, took off for California from an air field in Brooklyn, New York. He landed in Ireland.

6 On November 7,1940, the Tacoma Narrows Bridge, in Washington state, twisted wildly and collapsed. The twisting was caused by wind forces the designers had ignored.

7 In the early and middle parts of the century, powerful new antibiotic drugs were developed, saving countless millions of lives. By century's end, careless over-use of these drugs fueled many microbes to evolve resistance to them, thus endangering countless millions of lives .

http://cee.carleton.ca/Exhibits/Tacoma_Narrows/DSmith/photos.html

Screw-up #6: A few minutes after the first piece of concrete fell, this 600 foot section broke out of the suspension span, turning upside down as it crashed in Puget Sound. Note how the floor assembly and the solid girders have been twisted and warped. The square object in mid air (near the centre of the photograph) is a 25 foot (7.6m) section of concrete pavement. Notice the car in the top right corner.

8 In 1952, the de Havilland Comet, a commercial jet aircraft, made its debut. Twenty-one of this first model were built. Seven of them crashed due to a kind of metal fatigue that the designers had not considered.

9 On December 5, 1959, the Malpasset Dam in the Reyran Valley on the French Riviera cracked and burst. Its foundation, which was seated next to a seam of clay the designers had ignored, had shifted, causing the crack. More than 420 people died.

10 During the years 1958-62 a Chinese government-mandated technological revolution called "The Great Leap Forward" caused food production to plummet, which led to massive famine. Under orders, people over- and mis-used techniques that were copied from the Soviet Union (soil was plowed too deeply, seeds planted too densely, irrigation projects engineered badly if at all, etc.) Bureaucracy on all levels exacerbated the problem by decreeing that there was no problem. The death toll from the famine is estimated at 30-50 million people.

11 In 1962, Mariner 1, the first US spacecraft sent to explore the planet Venus, went off-course shortly after launch because of an error in its guidance computer program. The error was small: a wrong punctuation character in one line of code. The result was large: instead of going to Venus, Mariner 1 went into the Atlantic Ocean.

12 In the early 1970s, the new, 60-story Hancock Tower in Boston, one of the first tall buildings clad entirely with large mirrored glass panels, began shedding its 500-pound windows, one by one. The window material had been used in much smaller buildings, where it caused similar problems; the Hancock designers overlooked this fact. Sheets of plywood — more than an acre of them — were put up in place of the missing windows, and for years the streets in the neighborhood were covered with tunnels to protect pedestrians from the falling glass. The building also caused neighboring utility lines and foundations to crack, and induced nausea in its occupants when heavy winds blew.

13 On September 1, 1983, a Soviet Su-15 jet fighter mistakenly shot down a Korean Air civilian airliner near Sakhalin Island, USSR, killing 269 people.

14 On December 3, 1984, the Union Carbide chemical plant at Bhopal, India leaked toxic gas, killing more than 6000 people and injuring and/or debilitating many more.

15 On January 28, 1986, the space shuttle Challenger exploded shortly after liftoff because a sealing ring failed. The sealant material was known to be brittle in the cold, and the rocket had spent many hours sitting in cold weather prior to launch.

16 In April 1986, the Chernobyl nuclear power plant in Russia suffered a partial meltdown due to design deficiencies and sloppy maintenance. More than thirty people were killed in the short term, thousands more suffered severe illness and/or impairment, and a vast expanse of land, water and air was laced with radioactive contaminants.

17 On July 3, 1988, the US naval vessel Vincennes mistakenly shot down an Iran Air civilian airliner, killing 290 people.

18 In 1989, Martin Fleishmann and Stanley Pons, chemists at the University of Utah, announced their discovery of "Cold Fusion," a simple, inexpensive way to produce nuclear fusion. The method promised a future in which energy would be cheap and plentiful. The announcement triggered wild financial speculation and frenzied, unsuccessful attempts worldwide to demonstrate cold fusion. Later, it appeared that Fleischmann and Pons had based their claim on poorly documented, sloppy experiments, and were refusing to discuss the details. The insistent, extraordinary claim, together with the lack of information that would allow others to test it, made Fleischmann and Pons— and their idea—pariahs to much of the science community.

19 Juan Pablo Davila worked for the Chilean government-owned Codelco Company. In 1994, while trading commodities via computer, Davila accidently typed "buy" when he meant to type "sell." After realizing his mistake, he went into a frenzy of buying and selling, ultimately losing approximately .5% of the country's gross national product. His name thereupon became a verb, "davilar," meaning "to screw up royally."

20 And finally, comes the Y2K computer bug, the nature of which is all too well known to turn-of-the-century readers.

Marc Abraham is the editor of the Annals of Improbable Research *(AIR) and host of the long-standing annual Ig Nobel Prizes, awarded each fall in a special ceremony at Harvard University in recognition of "achievements that cannot or should not be reproduced." (See* APS News, *December 1999, for last year's Ig Nobel Prize recipients.)*

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