APS NEWS

July 1999 | The American Physical Society | Volume 8, No. 7

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APS 100 years — celebrate a century of physics

Science Advisors Past and Present Gather at APS Centennial

Former presidential science advisors from the days of President Dwight D. Eisenhower to the present gathered at the APS Centennial meeting in Atlanta for a special panel discussion on science policy past and present, reminiscing about their days in the White House with an eye to the future. [Current science advisor Neal Lane was scheduled to participate in the historic gathering, but was called back to Washington; his remarks were presented via videotape.]

Although session chair D. Allan Bromley joked that US President Thomas Jefferson had the best science advisor — namely, himself — and presidents have long sought scientific counsel, yet the position of national science advisor did not become official until James Killian was appointed to that post under Eisenhower. And while the role has changed since then, some common issues and concerns have endured. Don Hornig, who succeeded Killian under Eisenhower in 1960, recalls his tenure being dominated by three major issues: the Cold War with the Soviet Union, the space program, and basic research and education. The Vietnam War overshadowed the White House during the time that Ed David served under President Richard Nixon. He also found himself struggling with the onset of the energy crisis with the Arab oil embargo against the US, as well as setting NASA R&D priorities in the wake of the Apollo program's success. Guy Stever, who served under President Gerald Ford, came on board when the energy crisis was at its peak. "We were just beginning to realize that the environment, energy, and economic problems were all interwoven and we still haven't solved them," he said. "It may be the unfulfilled promissory note that the science and technology community has handed to society."

Frank Press, science advisor under President Jimmy Carter, found himself struggling to improve government ties to American industry and raise the Administration's awareness of issues of competitiveness and innovation. Concern over American industry's flagging competitiveness also figured prominently during the tenure of Jay Keyworth, science advisor to President Ronald Reagan. His White House days coincided with the emergence of a solution to the problem with the rise of the Silicon Valley computer industry. Keyworth's successor, Bill Graham, found himself extending economic concerns to fostering technology transfer between academia and industry, and to making government-sponsored innovations available to the commercial sector for development, triggering a critical shift in traditional science policy. "Until that time, the idea had been that government discoveries were public property and available to anyone," he said, unlike the commercial sector, which seeks to patent innovations.

As science advisor to President George Bush, Bromley found himself fostering international collaboration in science and technology, most notably through the formation of the Megascience Forum — a commitment further strengthened by the demise of the Superconducting Super Collider. Much of Jack Gibbons' efforts as science advisor to President Bill Clinton focused on developing a post-Cold War paradigm for national science policy, specifically the role and rationale for public support of science and technology — an issue which became more critical as reduction of the bloated national deficit moved to the forefront of the Administration's national priorities. Maintaining the nuclear weapons stockpile was another concern, along with bioethics, global climate change and population growth.

Steven J. Swieter of Swieter Images

Science advisors past and present take a breather from policy issues at the APS Centennial meeting in Atlanta: (from left) Jack Gibbons, D. Allan Bromley, Bill Graham, Jay Keyworth, Frank Press, Guy Stevers, Ed David, and Don Hornig.

Today, the full impact of the end of the Cold War on federal funding priorities can be clearly seen. According to Lane, high technology accounts for more than half the growth of the gross domestic product (GDP), as well as most of the capital gains tax revenue. Information technology alone accounts for 80% of stock market capitalization.

Not surprisingly, the position of presidential science advisor comes with an equal mix of successes and frustrations. Hornig struggled with the diversion of the Vietnam War, but cites

Continued on page 7

APS Statement on National Security and the Open Conduct of Science

The Council of the American Physical Society emphasizes the critical connection between US national security and scientific research activities. Effective national security requires the highest standards of vigilance and circumspection, and the science on which it is based must meet the highest standard of excellence. However, national security will ultimately be damaged if the underlying science suffers as a result of government practices that indiscriminately discourage or limit the open exchange of ideas.

The Council of the American Physical Society recognizes the importance of protecting classified information. We urge Congress and the Executive agencies, in carrying out this responsibility, to employ measures and practices that will maintain the strength and effectiveness of the scientific activities on which national defense relies.

Over the course of many years, immigrant scientists as well as foreign visitors and students have contributed enormously to the American scientific enterprise. They have enriched our knowledge and culture, promoted the growth of our economy, and improved the quality of our lives. Any negative characterization of scientists on the basis of ethnic or national origins is destructive to science and American values.

Inside...

APS Joins Other Scientific Organizations To Endorse Statement on DOD S&T Funding

The APS, along with the American Institute of Physics (AIP) and the Optical Society of America (OSA), has joined sixteen other scientific and engineering associations in issuing a call to key Members of Congress urging a strong FY 2000 budget for the Defense Department's Science and Technology Program. The statement, endorsed by the APS Executive Committee and issued by the recently formed Coalition for National Security Research, was sent to members of the House and Senate Appropriations Subcommittees on Defense, the House Armed Services Subcommittee on Military Research and Development, and the Senate Armed Services Subcommittee on Emerging Threat and Capabilities. The text of the statement is at right. A list of endorsing organizations may be found in APS News Online.

The leaders of the listed organizations (see sidebar) urge Congress to increase the FY 2000 budget for the Department of Defense's (DOD) Science & Technology Program (S&T Program) to $8 billion. This represents a 2.6% increase over the current FY 1999 budget, and an 8% increase above the Administration's proposed budget. This increase will help stabilize funding that would decline at a precipitous rate in FY 2000, and in the projected out-years in DOD's five-year plan. This decrease undermines the science and technology base that is essential to U.S. security in the 21st century.

DOD's S&T Program supports research in the nation's universities that is the bridge between fundamental science discoveries and future military applications. DOD support of university research also plays a critical role in sustaining disciplines where it is a major source of federal funding. These disciplines make essential contributions to national defense by fueling innovation and training the scientists and engineers of tomorrow.

The S&T Program also funds research in the DOD laboratories, and private sector industries that focus on technologies to support future DOD systems. Increasingly important to DOD, this focus on the longer-term revolutionary changes in military technology will keep U.S. forces ahead of foreign competitors, and enable a quick response to emerging threats such as chemical and biological agents.

Eight billion dollars in FY 2000 for DOD's S&T Program would support the scientific and engineering research that has produced today's preeminent U.S. forces demonstrated most recently during Desert Storm and other peacekeeping missions. It is the continued investment in DOD's S&T Program that will maintain this technologically superior force for the 21st century.

To Advance & Diffuse the Knowledge of Physics

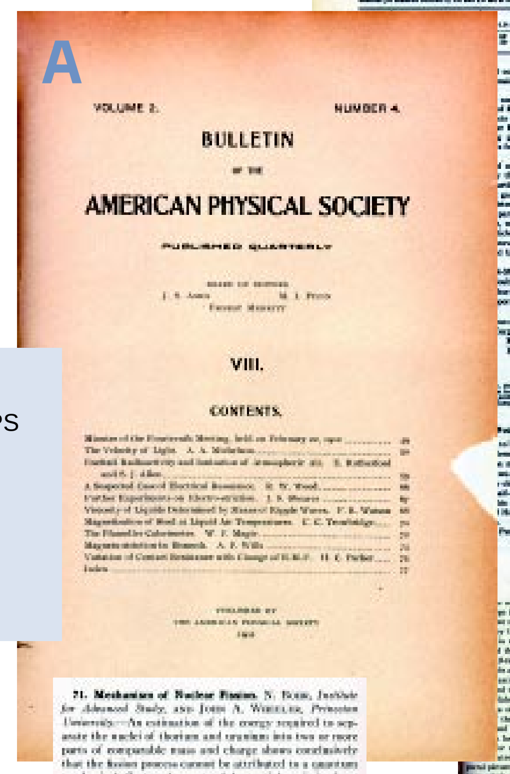
100 Years of the American Physical Society

Excerpts from an exhibit displayed at the APS Centennial Meeting.

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

Photo courtesy of the AIP Niels Bohr Library

Leo Szilard and E.O. Lawrence at a 1935 APS meeting in Washington, DC.



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VOLUME 2. NUMBER 4.

BULLETIN

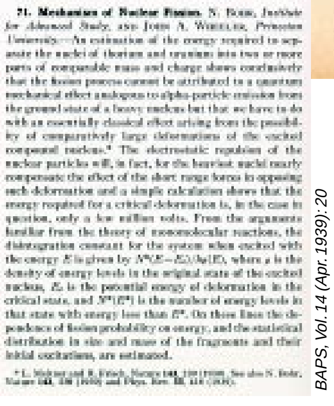
OF THE

AMERICAN PHYSICAL SOCIETY

PUBLISHED QUARTERLY

VIII.

CONTENTS.

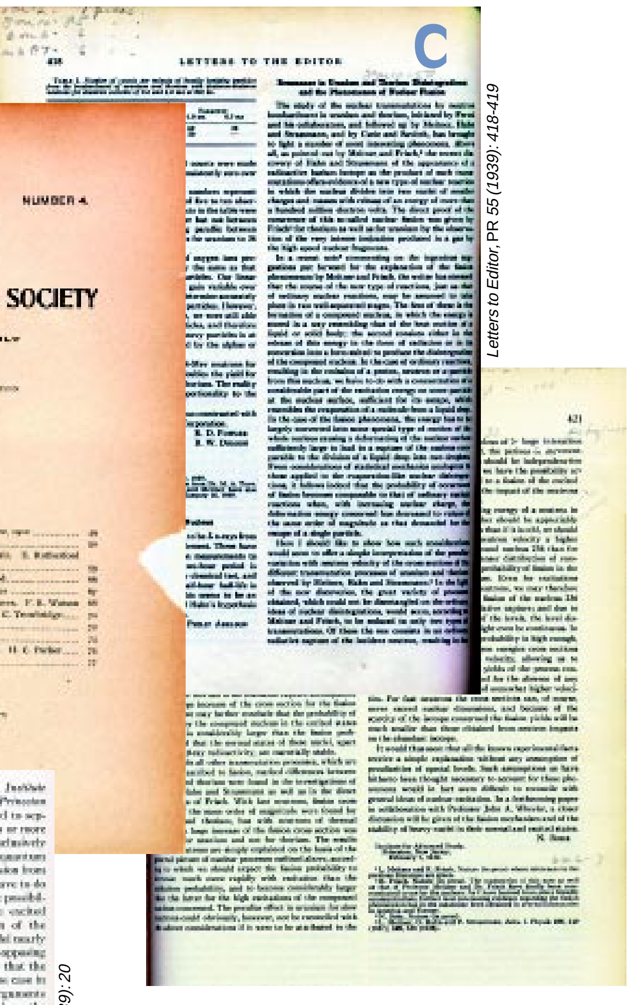


B

71. Mechanism of Nuclear Fission. N. Bohr, Institute for Advanced Study, and John A. Wheeler, Princeton University.—An estimation of the energy required to separate the nuclei of thorium and uranium into two or more parts of comparable mass and charge shows conclusively that the fission process cannot be attributed to a quantum mechanical effect analogous to alpha-particle emission from the ground state of a heavy nucleus but that we have to do with an essentially classical effect arising from the possibility of comparatively large deformations of the excited compound nucleus.[1] The electrostatic repulsion of the nuclear particles will, in fact, for the heaviest nuclei nearly compensate the effect of the short range forces in opposing such deformation and a simple calculation shows that the energy required for a critical deformation is, in the case in question, only a few million volts. From the arguments familiar from the theory of monomolecular reactions, the disintegration constant for the system when excited with the energy E is given by $N^*(E-E_0)/h\rho(E)$, where ρ is the density of energy levels in the original state of the excited nucleus, E_0 is the potential energy of deformation in the critical state, and $N^*(E^*)$ is the number of energy levels in that state with energy less than E^*. On these lines the dependence of fission probability on energy, and the statistical distribution in size and mass of the fragments and their initial excitations, are estimated.

[1] L. Meitner and O. Frisch, Nature 143, 239 (1939). See also N. Bohr, Nature 143, 330 (1939) and Phys. Rev. 55, 418 (1939).

BAPS, Vol. 14 (Apr. 1939): 20



C

LETTERS TO THE EDITOR

Letters to Editor, PR 55 (1939): 418-419

Scientific Announcements at Meetings

The *Bulletin of the American Physical Society* published reports and abstracts of APS meetings from 1899-1903, when the *Physical Review* took over this job. *BAPS* was revived in 1925. (See *Lessons from BAPS* on page 3)

A. Title page of a 1902 BAPS issue listing important papers by Michelson and Rutherford.

B. Abstract of a contributed paper by Bohr and Wheeler, which was among the first on fission presented at an APS meeting (April 1939).

C. Related work by Bohr published in Phys. Rev. *(1939).*

Speaking of Physics...

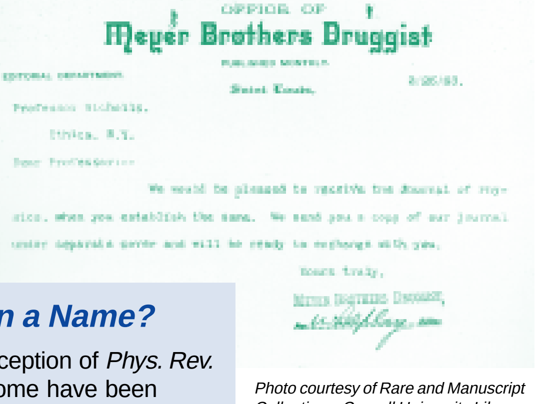
Scientific communication was the principal object of the early APS and the *Physical Review.* The journal appeared every other month until 1897, when it became a monthly. APS at first held four to five meetings per year—whether or not anyone had anything to report! Sometimes a telegram from the secretary was the first alert a member had that he was on an upcoming program.

Meetings

Meetings were held at Columbia University, the National Bureau of Standards, and jointly with the physics section of the AAAS. These early venues reveal the Society's roots and ties.

APS conferees in 1910 outside of the National Bureau of Standards in Washington.

Photo courtesy of the AIP Niels Bohr Library



OFFICE OF

Meyer Brothers Druggist

PUBLISHED MONTHLY.

EDITORIAL DEPARTMENT.

Saint Louis. 2/23/93.

Professor Nichols,

Ithica, N.Y.

Dear Professor:—

We would be pleased to receive the Journal of Physics, when you establish the same. We send you a copy of our journal under separate cover and will be ready to exchange with you.

Yours truly,

MEYER BROTHERS DRUGGIST,

Photo courtesy of Rare and Manuscript Collections, Cornell University Library.

What's in a Name?

Since the inception of *Phys. Rev.* and APS, some have been misled by the word *physical* in their titles. They assumed that the institutions promoted good health or *physic.* The problem persists to the present day, when venture capitalists have tried to buy APS and the U.S. Post Office has compared *Phys. Rev. Letters* to periodicals such as *Boxing World.*

Letter from Meyer Brothers Druggist to Phys. Rev. editor, Edward Nichols, 23 Feb 1893.

Clocks and Time Slots

In 1921, APS secretary D.C. Miller introduced a "sensational device," a clock to warn speakers that their ten minutes were up. Until 1999, kitchen timers were a fixture at APS meetings.

The 1920s also saw the introduction of parallel sessions to handle the increased number of papers.

Next month: *Growth in Membership and Meetings*

APS News

Coden: ANWSEN ISSN: 1058-8132
Series II, Vol. 8, No. 7 **July 1999**

Editor .... Barrett H. Ripin
Associate Editor .... Jennifer Ouellette
Design and Production .... Alicia Chang
Copy Editing .... Danita Boonchaisri

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

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

Subscriptions: *APS News* is an on-membership publication delivered by Periodical Mail. Members residing abroad may receive airfreight delivery for a fee of $20. **Nonmembers:** Subscription rates are: domestic $160; Canada, Mexico, Central and South America, and Caribbean $180; Air Freight Europe, Asia, Africa and Oceania $210.

Subscription orders, renewals and address changes should be addressed as follows: **For APS Members**—Membership Department, The American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org. **For Nonmembers**—Circulation and Fulfillment Division, American Institute of Physics, 500 Sunnyside Blvd., Woodbury, NY 11797. Allow at least 6 weeks advance notice. For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing issues will be honored without charge only if received within 6 months of the issue's actual date of publication.

Periodical Postage Paid at College Park, MD and at additional mailing offices. Postmaster: Send address changes to *APS News*, Membership Department, The American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Northwest Section Holds First Regional Meeting

Physicists from a wide range of sub fields in physics gathered in British Columbia, Canada, for the first meeting of the APS Northwest Section, held at the University of British Columbia in Vancouver, 21-22 May. More than 70 contributed abstracts were received, an especially strong showing for a fledgling geographical section, and 72 of the 189 registered participants were students. "This first meeting was very successful by most of the reasonable yardsticks for such meetings," said Eric Vogt of TRIUMF, one of the conference organizers, pointing to the strong attendance.

Because the meeting was a formative one, special efforts were made to bring together participants drawn from the various institutions spread over the northwest regions of Canada and the US, including the University of Washington, Oregon State University, University of Colorado/JILA, Eastern Washington University, Washington State University, TRIUMF, the University of Calgary, Montana State university, and Simon Fraser University in Burnaby, BC. To foster collegial interaction, the scientific sessions were supplemented by such social activities as a Thursday evening reception, Friday evening's salmon barbecue banquet, and a beer and pizza session on Saturday evening following the completion of the technical program.

In a Friday morning plenary lecture, Craig Hogan of the University of Washington discussed using supernovae to survey spacetime. Deep surveys of many kinds show that space and the matter within it, averaged over large volumes, are nearly uniform and uniformly expanding with time. Within this simple framework, however, there are still many possible universes with various spatial geometries and expansion histories. According to Hogan, exploding stars called Type Ia supernovae now give a brightness standard for measuring large distances with sufficient precision to begin to measure the history of the cosmic expansion and the large scale geometry of space. Two international teams have recently succeeded in obtaining high quality data on a few dozen supernovae at redshifts between 0.5 and 1 which indicate that the universe may be bigger and emptier than we expected, and likely to expand for much longer than it already has. The rate of expansion may even be accelerating, a sign that the universe may be driven apart by the repulsive gravity of an exotic new form of energy, such as Einstein's Cosmological Constant. Other plenary speakers covered such topics as Bose-Einstein condensates, spectral hole burning applications, quantum information and computation, electroweak physics, the growth of gallium selenium in silicon, nanophysics and the universal quantum of heat flow, neutrinos and muons.

Friday afternoon featured a special focus session on education. Janet Tate of Oregon State University described the recent restructuring of that institution's entire upper-division curriculum in an NSF-sponsored program called Paradigms in Physics. A series of nine "paradigms" -- sequentially taught modules which emphasize a particular physical concept and which cross the usual sub-discipline boundaries -- are followed by six deductive "capstones", which develop the individual sub-disciplines. "The approach shifts the framework of the upper-division curriculum more firmly to quantum mechanics from classical mechanics," said Tate.

According to Robert Gibbs of Eastern Washington University, from 1992-1997, Spokane Public Schools implemented an activity-based, elementary school science curriculum in its 35 elementary schools. The project was a collaborative effort between the school district and EWU, and its scope included 950 teachers, and 1600 science kits which are managed by a central facility. The majority of the kits were selected from the Science and Technology for Children and the Full Option Science System curricula. David R. Sokoloff of the University of Oregon in Eugene described how the results of physics education research and the availability of microcomputer-based tools have led to the development of student-oriented laboratory curricula like RealTime Physics. "One reason for the success of these and similar materials is that they encourage students to take an active part in their learning," he said. His talk focused on the use of Interactive Lecture Demonstrations to promote active learning in lecture and reported on recent results of studies on the effectiveness of this approach.

Finally, "Although most universities do a superb job of training graduate students in research, relatively few offer training to enable MS or PhD students to achieve the same level of mastery in teaching as a preparation for a career as a faculty member in a college or university," said Ken Krane of Oregon State University, which now offers a comprehensive program that prepares students for a variety of careers in physics teaching. For students interested in teaching at a two-year college, OSU offers an M.S. degree with a specialty in physics education along with a teaching intern program at a local community college. For PhD students, OSU offers a seminar that addresses a full range of pedagogical and methodological issues involved in physics teaching, an apprentice program that pairs each student with a faculty member of recognized teaching ability, and a capstone experience (following the completion of the PhD dissertation) as an instructor to fill sabbatical or other vacancies. According to Krane, "The impact of the program is measured by its extraordinarily high success at placing students in teaching jobs."

Another focus session on Saturday afternoon centered on industrial and applied physics. For example, a team of researchers from Montana State University in Bozeman has designed and tested a three-dimensional vibration isolation device using polyvinylidene fluoride (PVDF). The need for a low power, low current vibration damping system comes from space vehicles requiring low acceleration environments for sensitive experiments in microgravity with minimal resource utilization. The MSU system is built around twelve actuators arranged to actuate the isolation box in all six degrees of freedom. Actuators are made from silver-coated piezoelectric PVDF sheets.

Room and moderate-temperature oxygen sensor materials attract much attention owing to their wide prospective application in industry and household, according to Nickolay Golego of the University of British Columbia in Canada, who reported on the preparation and electronic characterization of polycrystalline thin-film titanium dioxide and zinc oxide for oxygen sensor applications in industry. He also discussed new preparation methods for polycrystalline phosphors, which have found wide application as an efficient blue primary in tricolor fluorescent lamps and plasma display panels. A drawback of the commercial powder process, however, is that high firing temperature (1600° C) is required. According to Golego, thin films may provide a viable alternative to powders. He and his collaborators have demonstrated for the first time a thin-film route to such preparation by spray pyrolysis, which is a convenient, low-temperature process applicable to many other phosphors.

Lessons from *BAPS*: Vol 1 (Second Series)

by Harry Lustig, Sante Fe NM

The *Bulletin of the American Physical Society* (BAPS) was created by the founding assembly of the Society on May 20, 1899. In 1902, BAPS was discontinued and its functions of recording the proceedings of the Society's meetings were subsumed by *The Physical Review*. APS resumed publication of its *Bulletin* in 1925. This Second Series carried not only the announcements and presubmitted abstracts of the scientific meetings, but also matters of record, such as lists of the APS membership and other material of interest to the members. Examination of the *Bulletin*, at periodic intervals, therefore conveys not only interesting information about the progress of physics and the structure of the meetings, but also about the sociology of the profession and of the country. Excepts from Volume 1, covering 1925 and 1926, give a snapshot of that era.

Frequency, Location, and Structure of the Meetings

By this time, the tradition of holding all meetings in New York City (which meant at Columbia, the Society's *de facto* headquarters) had been replaced by holding only the annual winter meeting there. The Society regularly held a spring meeting in Washington, DC at the Bureau of Standards (which the APS was instrumental in forming) plus three or four regional meetings around the US each year.

Most meetings were scheduled for two full days. Although most had single, consecutive sessions, some doubling up had already become necessary. In theory a "Program Committee" was to approve abstracts for presentation, but in practice this requirement was usually ignored until much later when a "Committee for Eccentric Abstracts" was temporarily in operation. According to one notice in the *Bulletin*, the abstracts of contributed papers were to be limited to 211 (!) words.

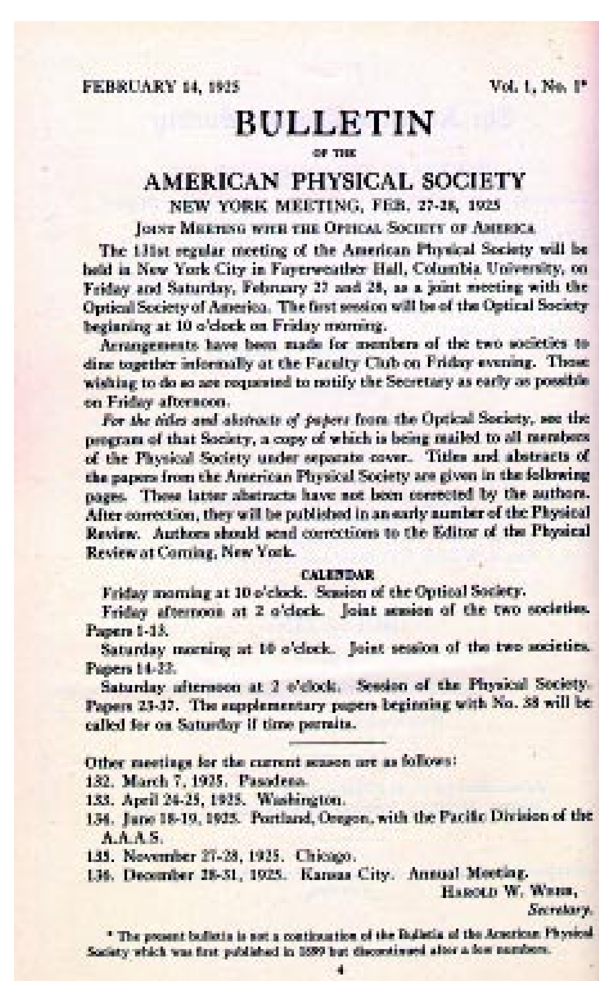
Some meetings were held jointly with those of other associations. As part of a long-lasting tradition, the annual meetings were joint with those of Section B (Physics) of the American Association for the Advancement of Science (AAAS), a progenitor of the APS.

Contributed Papers: Geographical and Workplace Distribution of Authors

With the exception of the annual Washington gathering, most contributed paper sessions at the meetings had a decidedly regional flavor, surely because of the time and cost of long-distance travel. Thus at the New York meeting of 1925, all of the 23 papers from academic institutions came from the East or nearby, with the exception of one from Washington University in St. Louis. Over one-third of the papers were from government, industrial and other non-academic laboratories. The high proportion of non-academically based authors at this meeting, and at several other meetings during this period, should cast doubt on the commonly held belief that the APS was not hospitable to industrial and government research.

In sharp geographic contrast, at the Pasadena meeting, 15 of the 20 contributed papers were from Cal Tech, including papers authored by Linus Pauling, Paul Epstein, H.P. Robertson and R.A. Millikan. The annual meeting in Kansas City had its center of mass in the Midwest, with a slight list to the south. In line with the composition of the physics profession, most of the authors were men with a sprinkling of women.

The academic or job titles of authors were never given, except for one select group, the National Research (Council) Fellows. This unique fellowship support program played an important role in furthering the development of the most promising American physicists and other scientists of the period. National Research Fellows giving contributed papers in 1925-26 included J.W. Beams, Otto Laporte, and Ernest O. Lawrence.



FEBRUARY 14, 1925 Vol. 1, No. 1*

BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

NEW YORK MEETING, FEB. 27-28, 1925

JOINT MEETING WITH THE OPTICAL SOCIETY OF AMERICA

The 131st regular meeting of the American Physical Society will be held in New York City in Fayerweather Hall, Columbia University, on Friday and Saturday, February 27 and 28, as a joint meeting with the Optical Society of America. The first session will be of the Optical Society beginning at 10 o'clock on Friday morning.

Arrangements have been made for members of the two societies to dine together informally at the Faculty Club on Friday evening. Those wishing to do so are requested to notify the Secretary as early as possible on Friday afternoon.

For the titles and abstracts of papers from the Optical Society, see the program of that Society, a copy of which is being mailed to all members of the Physical Society under separate cover. Titles and abstracts of the papers from the American Physical Society are given in the following pages. These latter abstracts have not been corrected by the authors. After correction, they will be published in an early number of the Physical Review. Authors should send corrections to the Editor of the Physical Review at Corning, New York.

CALENDAR

Friday morning at 10 o'clock. Session of the Optical Society.

Friday afternoon at 2 o'clock. Joint session of the two societies. Papers 1-13.

Saturday morning at 10 o'clock. Joint session of the two societies. Papers 14-22.

Saturday afternoon at 2 o'clock. Session of the Physical Society. Papers 23-37. The supplementary papers beginning with No. 38 will be called for on Saturday if time permits.

Other meetings for the current season are as follows:

132. March 7, 1925. Pasadena.
133. April 24-25, 1925. Washington.
134. June 18-19, 1925. Portland, Oregon, with the Pacific Division of the A.A.A.S.
135. November 27-28, 1925. Chicago.
136. December 28-31, 1925. Kansas City. Annual Meeting.

HAROLD W. WEBB,
Secretary.

* The present bulletin is not a continuation of the Bulletin of the American Physical Society which was first published in 1899 but discontinued after a few numbers.

4

Invited Papers and Other Events

In the early years invited papers were rare at APS meetings and manifestly opportunistic. At the February 1925 meeting, there was a talk by P. Debye (who was visiting MIT from Zurich) on the diamagnetism of gases at low pressure. There were joint sessions of APS and Section B, featuring the retiring address of the Section B

Continued on page 7

FESTIVAL PROFILE

Foam: Food for Thought

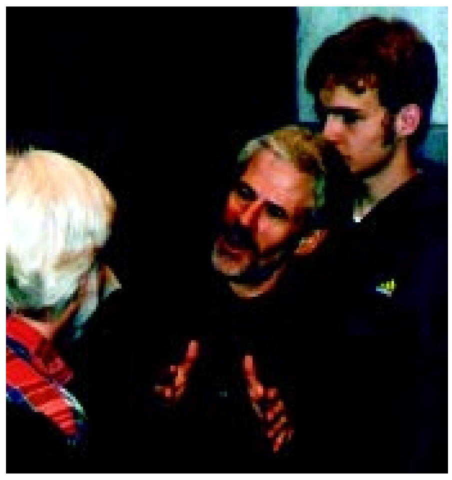
Beer is 'head' food with universal appeal, judging by the physicists and general public alike who crowded into the Georgia Pacific Building auditorium in Atlanta at the end of the hectic, week-long APS Centennial meeting to hear Emory University's Sid Perkowitz. There he elucidated not only the physics of beer, but also of bread, soufflés, meringues, mousses, whipped cream (both real and "non-dairy"), cappuccino and latte, marshmallows, champagne, carbonated soda and other foamy food and drink. "There is a lot of science, technology and just sheer human ingenuity that goes into some of these foods, and the techniques employed [to create them] are highly evolved, some dating back thousands of years," said Perkowitz.

Born and raised in New York City, Perkowitz recalls gravitating towards science early on in childhood, an interest fostered by his fascination with the collection of solid state crystals at the Museum of Natural History. "I think science for me was kind of an escape from emotional turmoil, along with reading and other intellectual activity," he says. "It's a way to operate in a world where human messiness doesn't enter in to a certain extent. I wouldn't be surprised if the same were true for other people in the field as well." A graduate of the Polytechnic Institute of Brooklyn, he went on to earn his PhD in solid state physics from the University of Pennsylvania. His research into the physics of solids and liquids and the optical properties of matter resulted in more than 100 papers and a book on the optical characterization of semiconductors.

About ten years ago, Perkowitz embarked upon what has become almost a second career, drawing on his knack for writing about science for the popular readership, which he attributes to being a voracious reader in his youth: "I always said from an early age that although science was definitely my first choice, writing would be my second," he says. He has written for many newspapers and magazines, and authored the book *Empire of Light*, published in 1996. His latest book for a popular audience is *Universal Foam*, slated for publication in early 2000, with an entire chapter devoted solely to foamy food and drink. [Watch out Martha Stewart!]

His interest in foamy foods and beverages began when he became intrigued by the complex structure of the bubbles in the foamed milk he made for cappuccino every morning.

A brief sampling of fun foamy facts gleaned from the chapter on edible foams: (1) No-fat, ice cold milk froths the best. (2) Non-dairy aerosol whipped cream contains polysorbate-60 and xanthan gum, both ingredients found in shaving cream. (3) You get a fluffier meringue if you beat the egg whites in a copper bowl. (4) Beers with smaller "heads" of foam actually taste better than those with more aesthetically pleasing larger heads. (5) Beer and bread are closely related; when beer is brewed, it produces a fermenting agent called "barm" as a froth, which is then skimmed off and used to make raised bread. (6) To retain its effervescence the longest, it is best to drink champagne from tall skinny glasses (and, adds Perkowitz, "as often as possible").



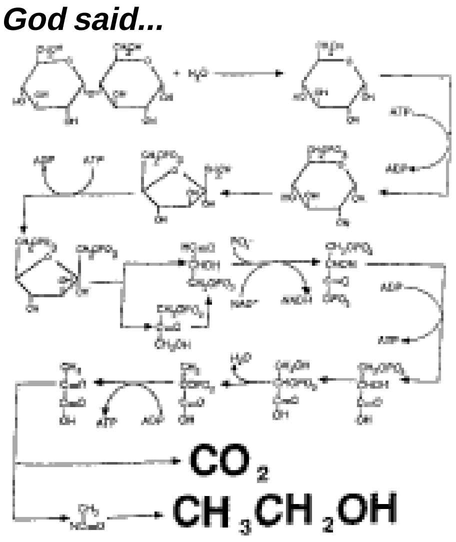
Sid Perkowitz (in a between-beer break).

He also delivers some fascinating historical trivia with the science. For instance, in 17th century France, the light fluffy bread preferred by the aristocracy was believed to lead the common people (who consumed a solid sourdough bread made without yeast) into "immoral behavior." Ancient Egyptians were baking raised bread as long as 6000 years ago. During the 1800s in America, yeast was also viewed with suspicion until Austrian brewer Charles Fleischmann demonstrated that better bread could be made with yeast. And the first person to make artificial carbonated water was British physicist Joseph Priestley, who unwittingly launched today's multi-billion-dollar soft drink industry as a result.

But the book isn't limited to edible foam. Other chapters cover such diverse topics as the physics and mathematics of soap bubbles, as well as of solid and liquid foams; the puzzling dynamical behavior of bubbles in the phenomenon of sonoluminescence (popularized a few years ago by the film *Chain Reaction*); biological systems and applications based on bubbles and foam-like geometry, such as insect and fish nests made from foam; bubble-enhanced ultrasound imaging; naturally-occurring pumice and sea foam; and foam technology such as packing peanuts and aerogel, a solid foam constructed from glass and air that serves as an excellent heat insulator, and is already being used on NASA spacecraft.

Should science, writing and beer eventually lose their appeal, Perkowitz has a third alternative career already waiting in the wings. — "a secret desire to be a racing car driver."

And God said...



And then there was beer...
And it was good...
And <u>then</u> came the seventh day

"The Physics of Beer" ©1988, A.W. Taylor II

zero gravity

The Astronomer's Drinking Song*

Author Unknown

It should come as no surprise to anyone that astronomers have their very own drinking song. [All that nighttime stargazing is bound to work up a thirst.] Not surprisingly, given the esoteric nature of the profession, the quality of the lyrics is several cuts above the old college standard, "99 Bottles of Beer on the Wall." The author is unknown, but the poem was written about 1800 and is included in Augustus De Morgan's *Budget of Paradoxes* (1866). And is to be sung to the well known ditty "The Vicar of Bray." Now if only we could locate a physicists' drinking song....

Whoe'er would search the starry sky,
Its secrets to divine, sir,
Should take his glass—I mean, should try
A glass or two of wine, sir!
True virtue lies in golden mean,
And man must wet his clay, sir;
Join these two maxims, and 'tis seen
He should drink his bottle a day, sir!

Old Archimedes, reverend sage!
By trump of fame renowned, sir,
Deep problems solved in every page,
And the sphere's curved surface found, sir:
Himself he would have far outshone,
And borne a wider sway, sir,
Had he our modern secret known,
And drank a bottle a day, sir!

When Ptolemy, now long ago,
Believed the Earth stood still, sir,
He never would have blundered so,
Had he but drunk his fill, sir:
He'd then have felt it circulate,
And would have learnt to say, sir,
The true way to investigate
Is to drink your bottle a day, sir!

Copernicus, that learned wight,
The glory of his nation,
With draughts of wine refreshed his sight,
And saw the Earth's rotation
Each planet then its orb described,
The Moon got under way, sir;
These truths from nature he imbibed
For he drank his bottle a day, sir!

The noble Tycho placed the stars,
Each in its due location;
He lost his nose by spite of Mars,
But that was no privation:
Had he but lost his mouth, I grant
He would have felt dismay, sir,
Bless you! he knew what he should want
To drink his bottle a day, sir!

Cold water makes no lucky hits;
On mysteries the head runs:
Small drink let Kepler time his wits
On the regular polyhedrons:
He took to wine, and it changed the chime,
His genius swept away, sir,
Through area varying as the time
At the rate of a bottle a day, sir!

Poor Galileo, forced to rat
Before the Inquisition,
E pur si muove was the pat
He gave them in addition:
He meant, whate'er you think you prove,
The Earth must go its way, sirs;
Spite of your teeth I'll make it move,
For I'll drink my bottle a day, sirs!

Great Newton, who was never beat
Whatever fools may think, sir;
Though sometimes he forgot to eat,
He never forgot to drink, sir:
Descartes took nought but lemonade,
To conquer him was play, sir;
The first advance that Newton made
Was to drink his bottle a day, sir!

D'Alembert, Euler, and Clairaut,
Though they increased our store, sir,
Much further had been seen to go
Had they tippled a little more, sir!
Lagrange gets mellow with Laplace,
And both are wont to say, sir,
The philosophe who's not an ass
Will drink his bottle a day, sir!

****Cheers! Dedicated to the American Astronomical Society (AAS) on this, their centennial, year.***

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 of the articles in the July 1999 issue are provided below. If you would like to subscribe to the paper or online version of *RMP*, please contact the APS Membership Department at membership@aps.org or (301) 209-3280. George Bertsch, Editor.**

Nobel Prize Lectures in Physics—*H. Störmer, D. Tsui, and R. Laughlin* on the fractional quantum Hall effect.

Gamma-ray astronomy at high energies—*C. M. Hoffman et al.*

Searches for supersymmetric particles at the Tevatron collider—*M. Carena et al.*

Brane dynamics and gauge theory—*A. Giveon and D. Kutasov.*

Linear scaling electronic structure methods—*A. Goedecker.*

Spontaneous ordering of nanostructures on crystal surfaces—*V. Shchukin and D. Bimberg.*

Physics of reaction waves—*E. Merzhanov and E. Rumanov.*

Solar neutrino experiments (colloquium)—*T. Kirsten.*

The "friction" of vacuum, and other fluctuation-induced forces (colloquium)—*M. Kardar and R. Golestanian.*

Putting a New Spin on MRI with Laser-Polarized Nobel Gases

Researchers at several institutions around the US reported—progress toward developing next-generation magnetic resonance imaging (MRI) technology, to image the respiratory system during the APS Centennial meeting . Minimally-invasive, high-resolution imaging is expected to have critical clinical and research applications, including surgical pre-screening, assessing disease progression and response to therapy, investigating fundamental lung physiology, and studying the pulmonary effects of harmful agents.

According to Ron Walsworth of the Harvard-Smithsonian Center for Astrophysics (HSCA), the respiratory system has been the most challenging for non-invasive medical imaging. The current clinical methods involve nuclear-based techniques such as computed x-ray tomography of inhaled radioactive isotopes, which provide mediocre image resolution and involve significant exposure to ionizing radiation. Current MRI scanners produce high-resolution images using a powerful magnetic field to polarize protons in water molecules in the patient's body, much as a bar magnet aligns iron filings. These polarized protons are detected by radio waves and are processed in a computer to produce detailed images of internal soft tissue.

However, the lung has a convoluted tissue-gas interface—crucial for effective gas exchange between the blood and air—and low concentrations of water making conventional MRI ineffective. The new MRI machines under development detect signals from laser-polarized molecules of xenon and helium-3, producing images of lungs and airways with excellent anatomical detail in both animals and humans. It has also been used to image the lungs of patients with Chronic Obstructive Pulmonary Disease (a class of diseases which includes emphysema), with clear indications of regions of low lung ventilation caused by the disease, and much higher resolution than any other imaging technique.

The HSCA team recently demonstrated laser-polarized noble gas MRI using a simple, low-cost MRI system that provides a magnetic field about 1,000 times smaller than conventional MRI machines. Advantages include the possibility of using open geometry magnets — instead of the "claustrophobia-inducing closed magnets used in many hospital MRI units," says Walsworth — as well as low-cost portable MRI instruments for imaging lungs and sinuses. Furthermore, using gases and low magnetic fields will aid in such non-medical applications as imaging porous materials and the interior of metallic objects.

A group of researchers at the University of Michigan are investigating MRI using a similar customized laser optical pumping system to polarize molecules of xenon gas, delivered via single-breath doses. According to Scott Swanson, U-M Medical School, xenon has several advantages. "The gas dissolves in the bloodstream is non-reactive and safe in measured doses, and can be polarized in higher concentrations than water molecules. It also differentiates between tissue, blood, and gas.

Timothy Chupp, a U-M professor, says "While many technical obstacles remain before the technology is ready for human use, our results indicate it could be used to monitor perfusion through the heart,

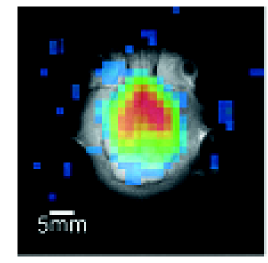


Image from http:// bearhat.rad.med.umich.edu/ ~scott/xeimages.html

Superposition of a false color ^{129}Xe image onto a ^{1}H spin-echo image showing that the ^{129}Xe signal arises entirely from within the brain as well as reduced ^{129}Xe in the cerebellum.

lungs and kidneys." Future research will focus on finding ways to increase xenon polarization to 5% to 35%, which will provide the resolution required for clinical applications.

Perhaps the best indication of the technology's potential is the emergence of a commercial company, Magnetic Imaging Technology, Inc. (MITI) in Durham, NC, founded to develop the advanced tools and capabilities needed to make hyperpolarized gas MRI imaging commercially feasible.

PHYSICS AND TECHNOLOGY FOREFRONTS

Micro Electro Mechanical Systems: Pyrite or Pure Gold ?

by Eric Peeters, Xerox Palo Alto Research Center (Peeters@parc.xerox.com)

"…Imagine a machine so small that it is imperceptible to the human eye. Imagine working machines with gears no bigger than a grain of pollen. Imagine these machines being batch fabricated tens of thousands at a time, at a cost of only a few pennies each…Imagine a realm where the world of design is turned upside down and the seemingly impossible suddenly becomes easy…. Welcome to the microdomain, a world now occupied by an explosive new technology known as MEMS…MEMS is the next logical step in the silicon revolution…We believe that the next step in the silicon revolution will be different, and more important than simply packing more transistors onto the silicon…" [excerpt from http://www.mdl.sandia.gov/ Micromachine/vision.html]

"…MEMS'97: Show me the Money !…",
"…Widescale progress but still no killer applications…",
"…MEMS market data: Another case of sorry-wrong number ?…"
[excerpts from 'Micromachine Devices' (from the editors of R&D Magazine), issues March and August 97]

These quotes from within the community express the existing spectrum of sentiments about the significance of a technology called Micro Electro Mechanical Systems (MEMS, US), aka Micro System Technology (MST, Europe), aka Micromachines (Asia) and about its impact on society two decades after the birth of the field. In 1982, Professor Kurt Petersen of Stanford University helped launch a new field by authoring a truly visionary publication, *Silicon as a Mechanical Material*,[1] in which he advocates the notion of using micro-electronics processing techniques and microelectronics materials to build microscopic parts with a *mechanical* function, in addition to the usual transistors and other electrical components. In 20 years, MEMS have literally gone from the Proceedings of IEEE to airline in-flight magazines, and MEMS technologists have amazed the world with awe-inspiring technological marvels constructed on micro-mechanical chips with intricate moving parts. But while anyone must admit the scientific and technological achievements have been magnificent by any measure, the opinions about how and when the long anticipated widespread economic impact might materialize are much more varied.

To the scientist or technologist, MEMS is like a dream come true. There is something magical about flicking on the electron microscope, zooming in and wandering through a micro-mechanical landscape that you thought up, created and understand, a world where laws of nature don't behave as the layman or novice expects based on their intuitions cultivated in the macroscopic world. The micro-machinist's building site is the size of a grain of rice, the architecture the size of a human hair, the building elements smaller than a red blood cell, …but our lithographic backhoes are the size of a city so we can construct a thousand sites at once. We have mastered the art of building the impossible, from gyroscopes, micro-motors, gear trains and transmissions, to fluid pumps, x-y tables and entire self-assembling optical bench erector sets.

The looks of this world may be wondrous, but its behavior is even more so. Despite our understanding of how bulk forces are supposed to scale down more quickly than surface forces with decreasing length scales, and despite our understanding that gravity effects should therefore disappear at some point, seeing something like Manhattan sitting comfortably balanced on top of something like the Empire State building takes some getting used to… (see photo caption...) especially if Manhattan is being moved back and forth electrostatically at a rate of 10 KHz with motion control much better than a city block. Your safest bet when first venturing into the world of MEMS, is to throw life-long intuition out the door altogether and to start cultivating a whole new intuition based on new experiences in the micro world.

Enamored by this wondrous new frontier and its parallels with microelectronics, we technologists have declared MEMS to be the second semiconductor revolution. We have claimed unconditional applicability of Moore's law and economies of scale, we have been predicting economic hockey stick curves and many of us believe that MEMS will soon become as pervasive in all aspects of every day life as microprocessors are today.

Three factors drive Moore's law in microelectronics: 'smaller is better,' 'smaller is cheaper' and the 'building blocks are universal across applications.'

However, none of these drivers is particularly valid for MEMS. The third is especially problematic. At the highest level of abstraction, the real power of microelectronics is not even its massively parallel fabrication paradigm. It is the existence of a generic element, such as the transistor, which allows us to build extremely diverse functionality 'simply' by implementing appropriate interconnection patterns within large collections of the generic elements. This is what makes semiconductor economics so vastly different from anything seen before in history. The impact of pushing the generic components along Moore's curve is therefore universal across all imaginable application areas, which in turn justifies massive spending on pushing even further along the curve. The 'gain factor' in the financial feedback loop is greater than one because of the 'generic element' paradigm.

In contrast, MEMS, by its very nature, does not have a set of generic elements. There is no MEMS 'transistor'. MEMS 'touch' and 'participate' in the physical world of the mixed bag of applications and therefore need to be much more application specific and less generic. In every aspect of design, modeling, manufacturing, packaging, etc. Thus, it is much more challenging to keep the gain factor that drives Moore's law greater than one. This is where many of the economic parallels with microelectronics break down and economics is evidently what makes the difference between a *possible* future and a *likely* future for a technology.

Although a 'second' silicon revolution with a magnitude close to the 'first' seems like a very tall order indeed, let there be no doubt that numerous MEMS-based products will enrich all of our lives in years to come. The economic successes may come via three routes:

The 'killer' applications may justify investments in totally dedicated manufacturing facilities. The revenue stream required to justify this sort of endeavor points to high volume products that are enabling at the function/system level itself and that are preferably accompanied by the sale of high margin

The background image is part of a 2-millimeter 'rotor disk' made out of polysilicon freely suspended in mid-air, only supported in the center by a 2-micron (!) 'anchor post.' The rotor is spun with electrostatic comb drive assemblies and optical modulators (right).

consumables or renewable services. Inkjet printheads are an existing example of this route to success.[2]

MEMS technology that is buried deeper, at the lower component levels of the 'food chain' and not intimately coupled to a secondary high margin revenue stream - such as from a consumable or renewable service - will be under pressure from the increasingly vigorous 'race to zero' in hardware cost. It may be that this class of MEMS components can be sustained over time if 'piggybacked' on existing or moderately customized semiconductor infrastructure. The ADXL series airbag accelerometers from Analog Devices have been an example of this route to success.

The third route is through the 'MEMS foundry' model, which may be viable in the long run if conceived with a fairly sharp application focus. If successful, this route may end up accounting for the majority of MEMS success stories in the next millennium.

Gold or Pyrite? No doubt there are plenty of pure gold nuggets in the MEMS ore. We have found some already. The next ones may well be in low-power reflective direct view displays for Personal Digital Assistants (PDA), or in wireless communication components that will allow your PDA to have access to the Web anywhere, anytime, and make it a pocket sized infinite information source. They may be found in the optical micro-mirror matrices that will switch broadband fiber communication to your home, or in disposable DNA diagnostics chips that won't leave you worried for days about the results of a critical blood test, or in…

[1] K. Petersen, *Silicon as a Mechanical Material*, Proc. IEEE, Vol.70, No.5, 1982, pp.420-457.
[2] E. Peeters, *Challenges in Commercializing MEMS, IEEE Comp. Sci. & Engr.*, Jan-Mar 1997.

General Election Preview — Members To Choose New Leadership for 2000

Ballots were mailed to all APS members in June and must be received by September 3, 1999 by SBS, an independent, external organization.

For Vice-President

JOHN DIRK WALECKA

Governor's Distinguished CEBAF Professor of Physics, College of William and Mary, Williamsburg, Virginia

Walecka received a PhD from MIT in 1958. He spent a year at CERN and another at Stanford on an NSF postdoctoral fellowship before joining the Stanford faculty in 1960. He became Professor Emeritus in 1987. In 1986, Walecka was appointed Scientific Director of CEBAF (now TJNAF, the Thomas Jefferson National Accelerator Facility), and served in that capacity until 1992, when he took a joint appointment as Senior Fellow at CEBAF and Governor's Distinguished CEBAF Professor at the College of William and Mary. In 1997, this appointment became full-time at William and Mary. Walecka is a theoretical physicist specializing in nuclear physics. In 1998, he gave the APS Primakoff Lecture and in 1996 was awarded the APS Bonner Prize for nuclear physics. Long active in the Division of Nuclear Physics (DNP), Walecka has been Division Councillor since 1998. In addition to various program advisory and visiting committees, he served on the Advisory Boards of the Institute for Theoretical Physics in Santa Barbara and Institute for Nuclear Theory in Seattle.

WILLIAM F. BRINKMAN

Physical Sciences Research Vice-President, Bell Laboratories, Lucent Technologies

As of 1993, Brinkman's responsibilities include the direction of research in physical sciences, optoelectronic and electronic devices, fiber optics and related areas. Previously he was Executive Director of the Physics Division at AT&T Bell Labs and Vice President of Research at Sandia National Laboratories in Albuquerque, NM. He received his PhD (physics) degree from the University of Missouri in 1965. He joined Bell Laboratories in 1966 and held the position of Director of the Physical Research Laboratory from 1981 until moving to Sandia in 1984. He returned to Bell Laboratories in 1987 to become Executive Director of the Physics Research Division. In 1993, he became Physical Sciences Research Vice President, his current position. He has worked on theories of condensed matter and his early work also involved the theory of spin fluctuations in metals and other highly correlated Fermi liquids. This resulted in a new approach to highly correlated liquids in terms of almost localized liquids. As manager of an industrial research organization with a budget of $200M, he is strongly interested in improving technology conversion and improving the connection between research and products. W. F. Brinkman was the recipient of the 1994 George E. Pake Prize.

For Chair-Elect of the Nominating Committee

LU JEU SHAM

Professor of Physics, University of California, San Diego

Sham is a condensed matter theorist, educated at Pui Ching Middle School, Hong Kong; Portsmouth College of Technology, Portsmouth; Imperial College, University of London (BSc); University of Cambridge, England (PhD). After three years as a research associate at University of California, San Diego, a year as an assistant professor at University of California, Irvine, and a year as a reader in applied mathematics at Queen Mary College, University of London, he returned to join the physics faculty in San Diego. He has served as Dean, Division of Natural Sciences (1985-89), Director, Institute for Pure and Applied Physical Sciences (1991-95), and Chair, Department of Physics (1995-98). Sham's research is mainly concerned with the interplay between many-body and lattice effects in solids. He has been working on the electron-phonon interaction, lattice dynamics, the density functional theory, non-conventional mechanisms for superconductivity, electronic properties and nonlinear optical processes in semiconductor heterostructures. He served four years concurrently on the Executive Committee of the Division of Condensed Matter Physics and as a General Councillor.

CURTIS G. CALLAN, JR.

Professor of Physics, Princeton University

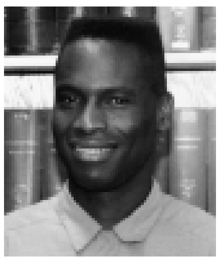
Callan is Professor of Physics and Chairman of the Physics Department at Princeton University. He works in theoretical elementary particle physics and his research has covered a wide range of topics, including the phenomenology of K-meson decays, the role of the renormalization group in QCD and the use of string theory to explain black hole entropy. He received his PhD in physics from Princeton in 1964. After a postdoctoral year at Princeton he held an assistant professorship in the Harvard Physics Department and a long-term membership at the Institute for Advanced Study. In 1972, he returned to Princeton as Professor of Physics and has remained there ever since. Apart from his teaching and his research in particle physics, he has been active for many years in advising U.S. government agencies on the applications of science and technology to national security problems. He has recently been very interested in the opportunities for physics and physicists in post-genomic biology and is working on the planning for an interdisciplinary Center for Genomic Analysis at Princeton.

For General Councillor

JIN-JOO SONG

Director, Center for laser and Photonics Research, Regents Professor of Physics and Noble Chair Professor of Photonics, Oklahoma State University

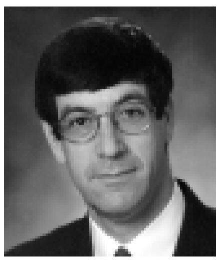
Song was born in Seoul, Korea. She received her PhD in experimental solid-state physics and quantum electronics from Yale University in 1974. She worked at MIT as a post-doctoral research associate, and later was on the faculty of the University of Southern California. In 1987, Song moved to Oklahoma State University where she now holds the positions of Regents Professor of Physics and Noble Professor of Photonics, as well as the Director of the interdisciplinary Center for Laser and Photonics Research. Song holds membership in the APS Division of Condensed Matter Physics (DCMP), Division of Materials Physics (DMP), and the Division of Laser Science (DLS). She has served the APS on the Committee on the Status of Women in Physics and Committee on Minorities, and was recently elected the 21st and first woman president of the Association of Korean Physicists in America. She is currently the principal investigator of the newly established multi-million dollar NSF Integrated Graduate Education and Research Training program at OSU, which focuses on multidisciplinary PhD training in Photonics. Song's present research interests include nanotechnology and ultrafast phenomena, especially widegap semiconductor quantum structures, epitaxial growth, characterization, and device fabrication.



PHILIP PHILLIPS

Associate Professor of Physics, University of Illinois, Urbana-Champaign

Born in Scarborough, Tobago, Phillips received his PhD from the University of Washington in 1982. After 2 years as a Miller Fellow at the University of California at Berkeley, he served on the faculty in the chemistry department at MIT from 1984 until 1993. In August of 1993, Phillips moved to the University of Illinois at Urbana-Champaign as an Associate Professor of Physics. His research is in theoretical condensed matter physics with a special emphasis on explaining experimental observations that challenge the standard paradigms of transport and magnetism in disordered and correlated electron systems. He recently received the Xerox Award for Faculty Research in the College of Engineering at Illinois.



MARK G. RAIZEN

Associate Professor of Physics, The University of Texas at Austin

Raizen directs an experimental research program that uses ultra-cold atoms to study the interface between nonlinear dynamics and quantum mechanics, quantum transport in optical lattices, and atom-surface interactions. He obtained a PhD in Physics from the University of Texas at Austin in 1989. He was then a postdoctoral fellow for two years at the National Institute of Standards and Technology in Boulder in the group of D.J. Wineland. Dr. Raizen was hired as an assistant professor at The University of Texas at Austin in 1991, and was promoted to associate professor with tenure in 1996. Raizen is a member of the Division of Atomic, Molecular, and Optical Physics (DAMOP), the Division of Laser Science (DLS), and the Precision Measurements Topical Group. He was awarded the APS I.I. Rabi Prize this year.

Continued on page 7

NOMINATIONS – 2000 BYLAW COMMITTEES

*To be submitted by members of the American Physical Society **only**.*

The Committee on Committees has the responsibility for nominating elected members of the Publications Oversight Committee and the Lilienfeld Prize Committee and for advising on suitable candidates to serve on the following Bylaw Committees appointed by the President:

Careers and Professional Development • Constitution and Bylaws • Education • Fellowship • International Freedom of Scientists • International Scientific Affairs • Investment • Meetings • Membership • Minorities • Status of Women in Physics • Physics Policy

The APS needs recommendations from the membership. Current personnel and last year's annual reports for many of the committees are on the APS Homepage under the Governance button. Please provide the name and affiliation of nominees and include information on career highlights and suitability for the position. Self-nominations are encouraged. (Please verify that your nominees are APS members prior to submitting your form.)

THIS YEAR, THE FORM WILL BE DOWNLOADABLE FROM THE FOLLOWING URL: HTTP://WWW.APS.ORG/MEM-CGI/COC

If you would like a copy of the form faxed to you, please e-mail Danita Boonchaisri at boonchai@aps.org and include your name and fax number.

The deadline for receipt of nominations is 9 August 1999

Thank you.

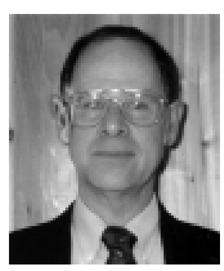
General Election Preview, *continued from page 6*

EBERHARD BODENSCHATZ
Associate Professor of Physics, Cornell University

Bodenschatz is an Associate Professor of Physics at Cornell University. His research is in the field of statistical and nonlinear physics with particular interest in pattern formation, spatio-temporal chaos, and fluid turbulence. He received his doctorate in 1989 from the University of Bayreuth (FRG) for his theoretical investigations in pattern formation of convection in liquid crystals. After a postdoctoral appointment at the University of California at Santa Barbara he joined the faculty at Cornell University in 1992 as an Assistant Professor of Physics. Within the APS he is a member of the Division of Condensed Matter Physics (DCMP), the Division of Fluid Mechanics (DFD) and the topical group on Statistical and Nonlinear Physics. In 1996/97 he was a member of the Network Publishing Task Force of the APS and is currently a member of the Public Face of Physics program of the APS and a member at large of the executive committee of the topical group on Statistical and Nonlinear Physics.

MARGARET M. MURNANE
Professor of Physics, University of Colorado

Murnane is currently in the Physics and Electrical Engineering Departments at the University of Michigan, and will join JILA and the Department of Physics at the University of Colorado in August of 1999. Murnane received her PhD degree in physics from the University of California at Berkeley in 1989. She remained at Berkeley for one year as a postdoctoral fellow, before joining the faculty of physics at Washington State University in 1990 and then the University of Michigan in 1996. Her research interests have been in ultrafast optical science. In particular, her work has made it possible to generate visible and x-ray pulses of a few cycles in duration, using extreme nonlinear optical interactions. Within the APS, she is a member of the Division of Atomic, Molecular and Optical Physics (DAMOP) and the Division of Laser Science (DLS), participated in APS-CSWP sponsored site visits to improve the climate for physics, as well as on efforts to change the public face of physics. Her previous honors include the APS Simon Ramo Award, and the 1997 Maria Goeppert-Mayer Award.



GREG NORTON
Vice President of Sales, Marketing and Quality Assurance, National Electrostatics Corporation

Norton joined NEC in 1975 after receiving a PhD in experimental nuclear physics from the Ohio State University (1973) and completing a postdoctoral research position in the Nuclear Physics Department of Florida State University. He has served on the Boards of Directors of National Electrostatics and the Friends of the Geology Museum, University of Wisconsin. From 1975 through 1981 he was involved in the initial design and later the field testing of some of the world's largest electrostatic ion beam accelerators. Norton's responsibilities involve all phases of customer relations, product development and promotion of electrostatic accelerators and complete MeV beam analysis and materials modification systems. This involves the adaptation of the principles and techniques developed in experimental nuclear physics for use in a wide variety of applications. Norton is a member of the Divisions of Materials Physics, Nuclear Physics, Physics of Beams and the Forum on Industrial and Applied Physics.

STUART J. FREEDMAN
Professor of Physics, University of California at Berkeley; Faculty Senior Scientist, Lawrence Berkeley National Laboratory; Senior Scientist, Argonne National Laboratory

Freedman is an experimental physicist working in areas of nuclear and particle physics. He has held a joint appointment in the Berkeley Physics Department and the Lawrence Berkeley National Laboratory Nuclear Science Division since 1991. His research focuses on problems related to the fundamental weak interaction, symmetry breaking, neutrino mass, and particle searches. Freedman received his PhD in 1972 from Berkeley for his experimental test of Bell's inequality with a two-photon cascade in atomic calcium. He was instructor and lecturer working in nuclear physics at Princeton University until 1976 when he left to become assistant professor at Stanford University. He joined the Argonne Physics Division in 1982 as Staff Physicist, becoming Senior Physicist in 1986. In 1987, he joined the Chicago Physics Department as Professor joint with Argonne National Laboratory. He conducted experiments in nuclear physics and nuclear astrophysics at a number of small accelerators and neutrino experiments at the LAMPF accelerator at Los Alamos. He returned to Berkeley in 1991. He was the 1998-1999 chair of the APS Division of Nuclear Physics.

BERTRAM BATLOGG
Department Head, Bell Laboratories, Lucent Technologies

Batlogg is department head for the Materials Physics Research Department at Bell Laboratories in Murray Hill, NJ. His research is in the area of materials-based condensed matter physics with the goal of creating and understanding new materials and their phenomena, and exploring them for applications. He received his Physics Diploma from the Swiss Federal Institute of Technology (ETH) in Zürich, and the Doctorate in Natural Sciences degree also from ETH in 1979. He joined Bell Laboratories the same year and in 1986 became department head, first of the Solid State and Physics of Materials Research Department, then of the Materials Physics Research Department. Within the APS, he served the Division of Condensed Matter Physics in various functions and is also a member of the Division of Materials Physics and the Forum on Industrial and Applied Physics (FIAP).

Science Advisors, *continued from page 1*

the creation of the Korean Institute of Science and Technology as one of the highlights of his tenure. David, a pioneer of speech recognition in computers, laments that he was unable to introduce computers to the White House during his stint, although they are now integral to government operations. As for successes, "I'm proudest that I managed to survive," he joked. Stevers regrets the stalled talks with the Soviet Union due to increasing pressure on Nixon from the Watergate scandal, but considers his work re-establishing the Office of Science and Technology in the White House under Ford as his greatest success. Keyworth bemoaned the decline in trust between Congress and the scientific community, but found satisfaction in the creation of NSF research centers and the founding of the Presidential Young Investigator program.

Graham was disheartened by what he termed "the ineffectiveness of the national constituency formed by people in scientific fields," but said his "greatest pleasure was the sure knowledge that I was working for a man [Reagan] who had an unshakeable belief in the importance of S&T to the development of the future strength of the US" Bromley mourned his failure to convince the State Department of the importance of S&T to US foreign policy, and gained the most satisfaction from the success of the reinvigorated Federal Coordinating Council for Science Education and Technology (FCCSET). For Gibbons, a major frustration stemmed from what he termed the "political Newtonian principle" — "For every action there is a more than equal and opposite reaction in a finely tuned political process" — which hampers progress in government. Gibbons told an amusing story of an April Fool's joke during a morning staff meeting, successfully duping his White House colleagues into believing that the Antarctic ice sheet was melting and would soon flood the globe's oceans. Lane's recounting of frustrations and highlights remains to be told, but he did identify the need to establish funding criteria and priorities for science, as well as achieving greater diversity in the S&T workforce, as critical areas of concern for the future.

The panelists have taken interesting career paths following their stint in the White House, and remain at least minimally active in science policy. Hornig went on to serve as vice president of Kodak, president of Brown University and finally as professor of chemistry in Harvard's School of Public Health. David joined the staff at Exxon and spearheaded the construction of the company's R&D center. Press went on to head the National Academy of Sciences, and is currently a consultant and partner in a newly formed international consulting group. Keyworth has founded a handful of Silicon Valley and Web technology firms, along with a public policy foundation in Washington called the Partners in Freedom, devoted to understanding the new digital economy. Graham recently served on the Congressional commission to assess the ballistic missile threat, which issued its report last July. Bromley returned to Yale and is currently rebuilding its engineering department, and also served as APS President. Gibbons is now the Karl Compton lecturer at MIT. As for Stevers, following the end of his stint as science advisor, "I vowed never to work for anybody else full-time again. And I didn't."

BAPS, *continued from page 3*

chairman, K.T. Compton, on *Dielectric Constants and Molecular Structure.* Compton's chairmanship of AAAS' Section B illustrates the continued close connection and interlocking directorships of AAAS and APS.

All of the APS meetings sported a dinner at a hotel or club. The cost of these was $2.00 except for those in Washington, where it was $2.50. Washington appears to have been an exceptionally expensive city even then. By 1939 the cost of dinners dropped to $1.25 -$1.50 in Washington, evidently reflecting the Depression. In the 1930s, the rate for a single room at the Hotel Pennsylvania, in New York City, was $3.50. The *Bulletin* (six issues) could be subscribed to for $1.00 per year.

Governance, Membership and Other Information

In addition to programs, abstracts, and announcements of future meetings, the *Bulletin*, in 1925-26, published three other items. One was the constitution and bylaws of the Society. The second was the lengthy *Report by the Educational Committee of the American Physical Society on The Teaching of Physics - With Especial Reference to the Teaching of Physics to Students in Agriculture.* It was the fourth (and last) in a series of APS reports on the teaching of physics to various student constituencies and exemplifies the Society's long involvement, if intermittent, with education.

The most voluminous non-meeting oriented section of the *Bulletin* was the Membership List of July 1926. There were seven honorary members, all foreign: Svante Arrhenius, V.F.K. Bjerknes, Niels Bohr, H.A. Lorentz, Max Planck, Ernest Rutherford, and Emil Wiechert. Also listed by name were the Society's 487 fellows and 1658 ordinary members. There were an estimated 50 foreign members and fellows (in addition to the honoraries). The fellows included Abraham Joffe of Leningrad, Russia (as the USSR was designated in the Membership List); Charles Darwin of Edinburgh, Scotland; M. Le Duc De Broglie of Paris, France; Victor Hess of Graz, Austria; and Sir C.V. Raman of Calcutta, India. An E. Shrödinger of Zurich, Switzerland is also listed as a member, but not as a fellow. Apparently Schrödinger had refused fellowship because the annual dues were then $2 higher than for members and fellows also had to pay a one-time $3 entrance fee. Perhaps his name was misspelled in retaliation. More than a dozen of the members residing abroad, such as Edward Condon, were Americans who were studying or working there. Among the authentically foreign members (other than Canadians), Japan led the list with nine (they still lead the list of the most members outside of North America), China followed with five and the other countries represented—Italy, England, Poland, Germany, Holland, and Belgium—each accounted for three or fewer.

Harry Lustig was Treasurer of the APS for eleven years until 1996. He has authored a history of the APS that will appear in the American Journal of Physics, and can be accessed at http://www.aps.org/apsnews/current/079905.html.

THE BACK PAGE

Nuclear Weapons After the Cold War

by W. K. H. Panofsky

The Cold War is over but little has changed in respect to US nuclear weapons policy. Yet the nature of the threats to US security from nuclear weapons has shifted dramatically since the end of World War II. Today the likelihood of deliberate large-scale nuclear attack against the US is much less than the risk of a nuclear weapon accident,, unauthorized use, or the threat from the proliferation of nuclear weapons across the globe.

During the Cold War we saw a dramatic nuclear build-up, reaching a rate on the US side of more than 5,000 weapons per year. The current shift to a build-down of nuclear weapons, proceeds at a rate of around 1,500 per year. The peak of the build-up "enriched" the world with over 60,000 nuclear weapons—an insane figure on its face—considering that two nuclear weapons, with the explosive power of about one-tenth of the average weapons in current stockpiles, killed a quarter million people in Japan. The build-down has cut the Cold War peak by only about one-half.

One reason for this is that nuclear weapons have become symbols of political power, with their physical reality relegated into oblivion. We as physicists have a major responsibility to maintain public awareness of the awesome reality of nuclear weapons. This task is made even more difficult in that, thanks to the non-use of nuclear weapons since 1945 and the cessation of atmospheric nuclear tests, few have ever seen a nuclear explosion. The second reason for this vast nuclear arsenal has been the extension of the proclaimed utility of nuclear weapons beyond their "core mission." This concept of extended deterrence — using nuclear weapons to deter threats posed by non-nuclear, meaning conventional, chemical and biological weapons, or to use the threat of nuclear weapons to protect the interests of other nations — denied the policy makers a meaningful answer to the fateful question "When is enough, enough?"

All this is now behind us — or is it? Nuclear weapons are still viewed by many as symbols of power. The recent nuclear tests by India and Pakistan were largely motivated by politics, not by a profound and realistic analysis of security needs. The latest full review of US policy concerning nuclear weapons — the Nuclear Posture Review (NPR) of 1994 — retained a great deal of Cold War thinking. The magnitude of "required" forces was still determined by a list of thousands of nuclear targets which had to be covered. The policy underlying the NPR was designated as "reduce and hedge," meaning that, while the reducing trend illustrated should be continued, large non-deployed stockpiles should be retained in order to re-equip US nuclear delivery systems with additional warheads should a more hostile Russia reemerge. Since that time, there has only been one additional revision of official US nuclear weapons policy, which occurred last year. The only change was that the US should no longer be prepared to fight a "protracted" nuclear war, but be able to reply to a large variety of threats by a single response.

These official policies tended to subordinate the threat to a role distinctly secondary to the need of nuclear weapons to counter a large spectrum of specified conjectured threats. Yet the threat of nuclear proliferation is largest to the US. among all other nations. Being the world's dominant power politically, we have most to lose if nuclear weapons proliferate. Nuclear weapons concentrate the destructive energy which can be delivered by any vehicle carrying weapons of a given size and weight by a factor of approximately one million. They are in many respects the "great equalizer" among nations, in the same sense that in the Middle Ages, firearms equalized the power of the physically weak and physically strong individuals.

Potential proliferants can deliver small numbers of nuclear weapons in many ways. Note that the US developed a nuclear projectile system, the Davy Crockett, which could be handled by a single soldier. Thus nuclear weapons could be detonated on ships in harbor, delivered by light aircraft, smuggled across US boundaries, and deployed by ballistic and cruise missiles of a variety of ranges. Meaningful defense against such a spectrum of delivery options is impossible; defense of this country against hostile detonation must rely on dissuasion, not physical intercept. Dissuasion has many facets, some diplomatic, some military, including deterrence of the potential user of nuclear weapons through likely nuclear retaliation, and arms control. There is no evidence that deterrence is any less effective against "rogue" nations than it is against current member states of the nuclear club, including Russia or China, who have been technically capable of delivering nuclear weapons against the US for a long time.

A major effort to stem the proliferation of nuclear weapons culminated in the Nuclear Nonproliferation Treaty (NPT) in 1970, which was converted in 1995 into a treaty of indefinite duration. This treaty has been signed by more nations than signed the United Nations Charter, and its signatories are divided into 181 Non Nuclear Weapons States and five Nuclear Weapons States. Thus the NPT in essence is discriminatory. The Non Nuclear Weapons States signatories were persuaded that their national security would be better served by not possessing nuclear weapons than by owning them.

The nuclear nonproliferation regime as enshrined in the NPT encompasses a complex bargain. The Non Nuclear Weapons States signatories agree not to develop or to receive nuclear weapons and the Nuclear Weapons States agree not to furnish them to Non Nuclear Weapons States. A provision often forgotten is that Nuclear Weapons States agree to assist Non Nuclear Weapons States in the development of the peaceful applications of nuclear energy: nuclear power and medical and research applications. Above all, the Nuclear Weapons States agree to reduce the role of nuclear weapons as instruments of international policy, decrease their numbers, and work in good faith towards their eventual prohibition.

It is in this last respect that the Nuclear Weapons States are expected to face the most severe criticism: they will be rightfully accused to have not lived up to their side of the bargain. The arms control process has been stalled for some years. This failure will expose the US and Russia in particular to severe criticism in the next NPT review conference, scheduled for the year 2000. The commitment to erase the discriminatory nature of the NPT regime overtime by a regime of progressive restraint leading to eventual prohibition is an essential element of the NPT bargain. The Treaty is unlikely to endure indefinitely without the Nuclear Weapons States giving much higher priority to their obligations in this respect. I consider it extremely important to revitalize the arms control process; the future of world civilization remains at risk unless much more progress is made. Erasing the discriminatory nature of the present nonproliferation regime over time is a necessity and the US should take the lead in this quest. With its vast superiority in so many areas beyond nuclear weapons, the US has most to gain and least to lose by exercising such leadership.

The effort to stem proliferation of weapons based on new technology is indeed daunting. Never before has mankind succeeded in stemming proliferation of a new technology towards military goals once that new technology led to civilian applications. Thus, while preventing proliferation of nuclear weapons is an overriding necessity, such an achievement would be unprecedented in history. There is little question that today both the US and Russia possess excess nuclear weapons beyond reasonable national security needs. Yet the legislatures of both countries seem to be engaged in a race with one another as to who can most act against their own national security interests. Further, major reductions on both sides, agreements between the Executive branches, or reciprocal unilateral moves, are clearly desirable to reduce burdens in maintaining the residual stockpiles, and to reduce the chances of accidents or inadvertent use. The latter risk is a particular problem with respect to Russia today, since controls are eroding and the Russian Early Warning System has severely deteriorated.

Several proposals for further reductions have been made. The agreements reached by Presidents Clinton and Yeltsin at the summit in Helsinki provide for initiating negotiations toward a START III Treaty, reduce strategic stockpiles on both sides to the sub-2,000 level and which would initiate discussions on future provisions to cover nuclear warheads of all kinds. However, the US has unwisely linked initiation of START III talks to Russian ratification of START II, which is lingering in the Russian parliament and where the recent deteriorating US-Russian relations has extended that period of inaction.

In my view, US national security for the foreseeable future would be well served by a reciprocal reduction regime leading to a level of "a few hundred" nuclear weapons on the part of the US and Russia, which roughly matches the inventories of the other Nuclear Weapons States — China, France and the UK. At that level, nuclear weapons are still ample to discharge the "core mission" of deterrence. Restriction to this core purpose is tantamount to a policy of "no first use" in contradiction to the current policy of extended deterrence. It is worth noting that recently Germany and Canada, two NATO allies, have proposed that serious consideration be given for NATO to adopt a no-first-use doctrine; these proposals will receive some consideration at the NATO conference to be held later this year. These progressive restraints would go a long way in discharging the perceived obligations of the Nuclear Weapons States under the NPT, while still protecting US interests against hostile actions by other states. Yet such drastic reductions remain controversial despite the evident logic of the arguments supporting them.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W. K. H. Panofsky

All this begs the fundamental question: Can conditions ever be achieved in which the possession and use of nuclear weapons can be prohibited worldwide? Nuclear weapons cannot be "un-invented." Thus the best hope for mankind is to arrive at an international norm under which nuclear weapons are prohibited in just the same manner as an international norm exists today for prohibition, possession, and use of chemical and biological weapons. Such a norm would not reduce the risk to zero. There remains the risk of clandestine retention of nuclear weapons by those states now possessing them and the clandestine manufacture of nuclear weapons by "rogue" states and perhaps even sub-national groups. Obviously many steps can be taken to minimize such risks. However, the ultimate question remains whether the security of the US and the world is served better by accepting such residual risks, rather than living with the extremely dangerous and fragile situation we are facing today.

Today we are facing the problem of having issues such as these even considered by the public and the body politic. So many other events preempt the news and the political agenda. Indeed, the world is fortunate that nuclear weapons have not been used in anger since 1945, and that the "near accidents" involving nuclear weapons never resulted in a nuclear explosion. Yet the world cannot afford to postpone action severely restricting the number and use of nuclear weapons until a nuclear detonation actually occurs.

Wolfgang K. H. Panofsky is Director Emeritus of the Stanford Linear Accelerator. This article was adapted from his paper given at the APS Centennial Meeting in Atlanta, GA, on March 24, 1999. The full version can be found online at http://www.aps.org/apsnews/current/079912.html.