APS NEWS

DECEMBER 1999 THE AMERICAN PHYSICAL SOCIETY VOLUME 8, NO. 11

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APS 100 years celebrate a century of physics

William Brinkman Elected APS Vice President

Members of the APS have elected William F. Brinkman, physical sciences research vice president at Bell Laboratories/Lucent Technologies, to be the Society's next vice president. Brinkman's term begins January 1, 2000, when he will succeed George Trilling (Lawrence Berkeley National Laboratory), who will advance to become president-elect. Brinkman will become APS president in 2002. The 2000 president is James Langer (University of California, Santa Barbara). [Look for our annual interview with the incoming APS president in the January 2000 *APS News*.]

In other election results, Curtis C. Callan of Princeton University was elected chair-elect of the APS Nominating Committee, which will be chaired by Michael S. Turner of the University of Chicago and Fermilab in 2000. The Nominating Committee selects the slate of candidates for vice president, general councillors, and its own chair-elect. The nomination committee choices are then voted on by the APS membership. Elected as new general councillors were Stuart Freedman (University of California, Berkeley, Lawrence Berkeley National Laboratory), Margaret Murnane (University of Colorado), Philip Phillips (University of Illinois, Urbana-Champaign), and Jin-Joo Song (Oklahoma State University).

VICE PRESIDENT

WILLIAM F. BRINKMAN

Bell Laboratories/Lucent Technologies

Brinkman received his PhD in physics from the University of Missouri in 1965. He joined Bell Laboratories in 1966 after spending one year as an NSF Postdoctoral Fellow at Oxford University. He moved to Sandia in 1984, but 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. His responsibilities include the direction of research in physical sciences, optoelectronic and electronic devices, fiber optics and related areas.

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. Subsequent theoretical work on liquid crystals and incommensurate systems are additional important contributions he made to the theoretical understanding of condensed matter. 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. Brinkman was the recipient of the 1994 George E. Pake Prize.

In his candidate's statement, Brinkman spoke of the growing diversity of the physics community and the need for the Society to continue to embrace new groups with topical interests that range from applications in computing and communications to medicine. As electronic publishing moves into the mainstream, the APS must find a way to recover the charges paid by libraries for paper versions of its journals, perhaps, says Brinkman, through institutional flat fees. He also spoke of the need for the APS to continue to be involved in public affairs that relate to the concerns of its members as physicists. "High on this list must be the health of our physics research enterprise. We must work to make physics attractive to students and to create interesting career paths for them," wrote Brinkman. "Among other things, this requires working toward ensuring the necessary funds for our research."

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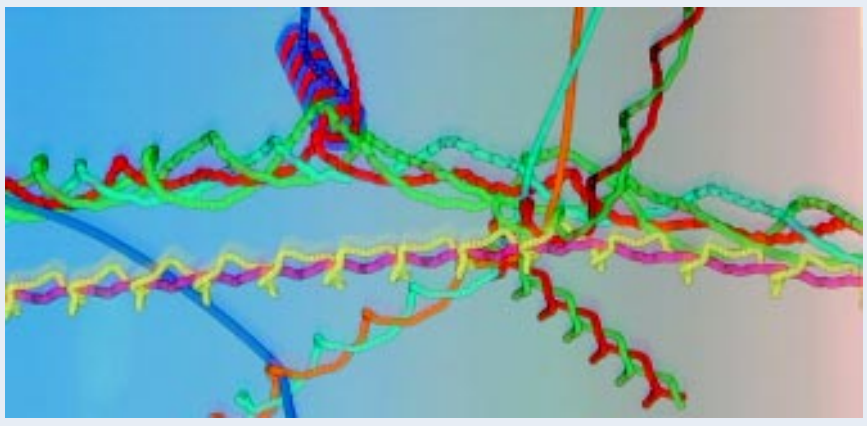
Atomic Collisions



Seen here is a 2D stroboscopic history of the collision of four diatomic molecules, a tetratomic molecule, and an atom. The image is one of a series by Eric Heller currently on display at the American Center for Physics. *See page 8 for more on the exhibit.*

Inside...

't Hooft and Veltman Awarded Nobel Prize in Physics; Zewail Wins Nobel Prize in Chemistry

In October, the 1999 Nobel Prize for Physics was awarded to Gerardus 't Hooft of the University of Utrecht and Martinus Veltman, formerly of the University of Michigan and now retired, for their work toward deriving a unified framework for all the physical forces. Their efforts, part of a tradition going back to the 19th century, centers around the search for underlying similarities or symmetries among disparate phenomena, and the formulation of these relations in a complex but elegant mathematical language. A past example would be James Clerk Maxwell's demonstration that electricity and magnetism are two aspects of a single electro-magnetic force.

Naturally this unification enterprise has met with various obstacles along the way. In this century quantum mechanics was combined with special relativity, resulting in quantum field theory. This theory successfully explained many phenomena, such as how particles could be created or annihilated or how unstable particles decay, but it also seemed to predict, nonsensically, that the likelihood for certain interactions could be infinitely large.

Richard Feynman, along with Julian Schwinger and Sin-Itiro Tomonaga, tamed these infinities by redefining the mass and charge of the electron in a process called renormalization. Their theory, quantum electrodynamics (QED), is the most precise theory known, and it serves as a prototype for other gauge theories (theories which show how forces arise from underlying symmetries), such as the electroweak theory, which assimilates the electromagnetic and weak nuclear forces into a single model.

But the electroweak model too was vulnerable to infinities and physicists were worried that the theory would be useless. Then 't Hooft and Veltman overcame the difficulty through a renormalization comparable to Feynman's. They succeeded in renormalizing a non-Abelian gauge theory. Getting the non-Abelian electroweak model to work was a formidable theoretical problem. An essential ingredient in this scheme was the existence of another particle, the Higgs boson, whose role is to confer mass upon many of the known particles. For example, interactions between the Higgs boson and the various force-carrying particles result in the W and Z bosons (carriers of the weak force) being massive (with masses of 80 and 91 GeV, respectively) but the photon (carrier of the electromagnetic force) remaining massless.

With Veltman's and 't Hooft's theoretical machinery in hand, physicists could more reliably estimate the masses of the W and Z, as well as produce at least a crude guide as to the likely mass of the top quark. Happily, the W, Z, and top quark were subsequently created and detected in high energy collision experiments, and the Higgs boson is now itself an important quarry at places like Fermilab's Tevatron and CERN's Large Hadron Collider.

The 1999 Nobel Prize in Chemistry was awarded to Ahmed H. Zewail of Caltech, for developing a technique that enables scientists to watch the extremely rapid middle stages of a chemical reaction. Relying on ultra-fast laser pulses, "femtosecond spectroscopy" can provide snapshots far faster than any camera—it can capture the motions of atoms within molecules in the time scale of femtoseconds.

An atom in a molecule typically performs a single vibration in just 10-100 femtoseconds, so this technique is fast enough to discern each and every step of any known chemical reaction. Shining pairs of femtosecond laser pulses on molecules (the first to initiate a reaction and the second to probe it) and studying what type of light they absorb yields information on the atoms' positions within the molecules at every step of a chemical reaction. With this technique, Zewail and his colleagues first studied (in the late 1980s) a 200-femtosecond disintegration of iodocyanide, observing the precise moment at which a chemical bond between iodine and carbon was about to break.

Since then, femtochemistry has revealed a whole new class of intermediate chemical compounds that exist less than

Continued on page 9

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.

Scientists at Los Alamos, circa 1942.

AIP Niels Bohr Library

Work at the Rad Lab, MIT.

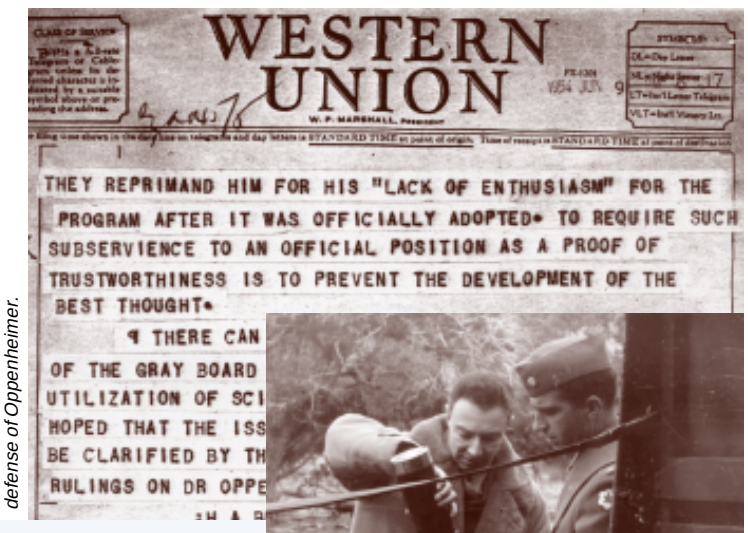
"The Physicists' War"

One consequence of World War II was the mobilization of physicists for war work. Radar research was undertaken at MIT's Rad Lab, and the atom bomb project was carried out at Los Alamos, Chicago, Hanford, and Oak Ridge.

Public Affairs

Until recently, the American Physical Society prided itself on its aloofness from matters of public policy. It saw itself as an organization devoted exclusively to the affairs of pure science. The archival record tells another story, and one of which the Society might equally be proud.

Time and again the Society entered the field of politics — with petitions to Congress, telegrams to news agencies, and well-placed letters — in order to defend the scientific integrity, freedom, and loyalty of its members. During the war years, the APS was responsive to the needs of national security without losing sight of the long-term goals of international cooperation.



Excerpt from Hans Bethe's 1954 telegram to the press in defense of Oppenheimer.

AIP Niels Bohr Library

Oppenheimer with Major W. A. "Lex" Stevens on a trip to select the test site for the first atomic bomb, 1944.

Science without Borders

In November 1945—three months after the end of the war—the APS Council voted to treat German and Japanese members the same as other foreign members. Gifts of wartime and postwar issues of the *Physical Review* and *Reviews of Modern Physics* were sent to German and Japanese universities in 1948.

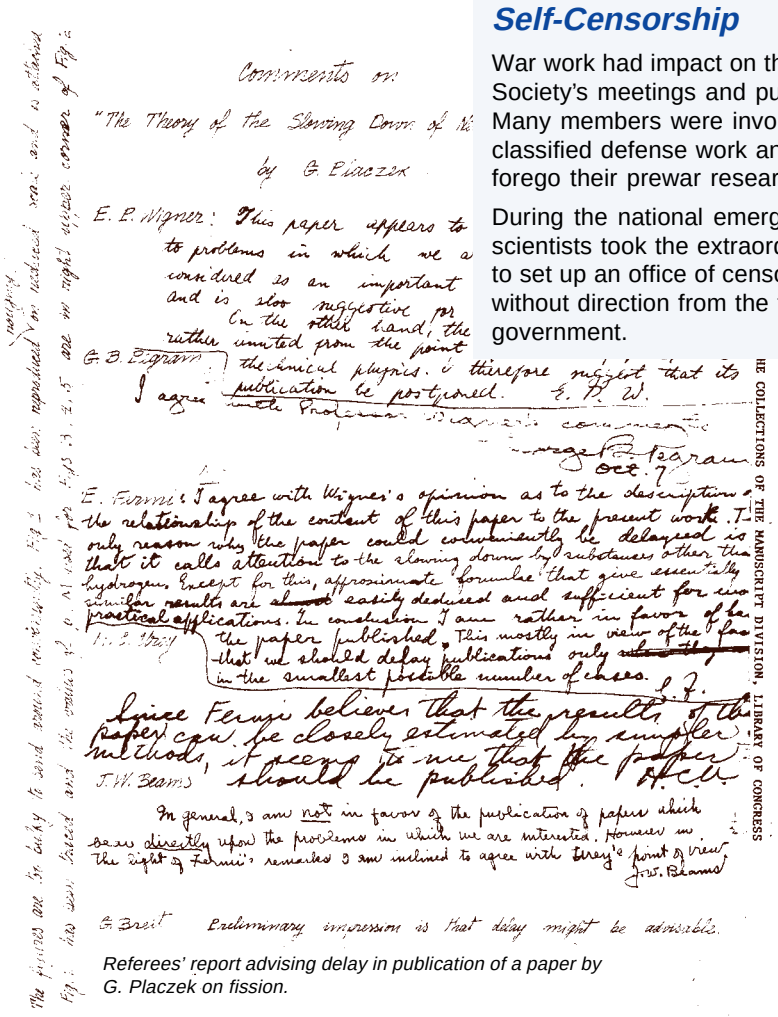
Such actions led McCarthyites to view many physicists with suspicion during the Cold War. Former APS presidents Edward Condon and Robert Oppenheimer were among those blacklisted.

AIP Niels Bohr Library

Self-Censorship

War work had impact on the Society's meetings and publications. Many members were involved in classified defense work and had to forego their prewar research.

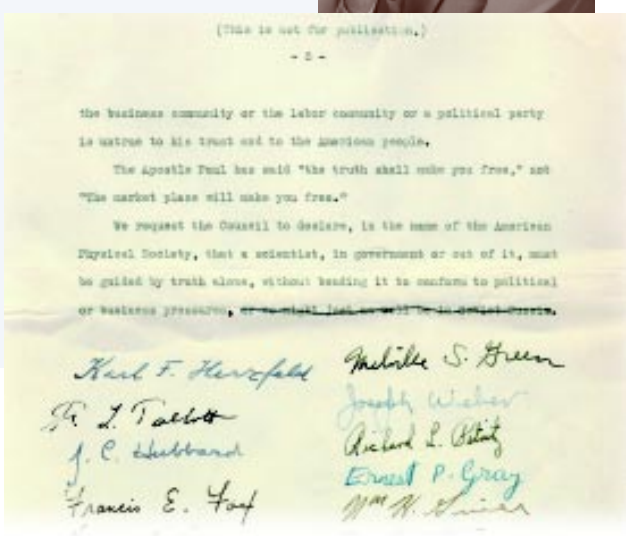
During the national emergency, scientists took the extraordinary step to set up an office of censorship without direction from the federal government.



Referees' report advising delay in publication of a paper by G. Placzek on fission.

Seeking Truth without Regard to Politics

In 1900, APS encouraged the U.S. Congress to set up the National Bureau of Standards. In 1953, APS again came to the Bureau's support when its director, Allen V. Astin, resigned under pressure from the Secretary of Commerce. At issue was a battery additive that NBS had tested and found did not extend battery life as advertised by the manufacturer. Astin was eventually reinstated.



AIP Niels Bohr Library

Petition submitted by Washington D.C. area APS members in April 1953 in support of Astin (detail).

Next Month: Consciousness Raising: Turbulent 60s

APS News

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New Faces at APS Headquarters

Two new people joined APS staff's College Park, MD, headquarters in October. Barbara Hicks joined the Society as associate publisher replacing Mina Chung, and Suzanne Otwell is the new education programs administrator, replacing long-time APS veteran Tara McLoughlin, who now works for the American Psychiatric Association.

Hicks comes to the APS after 18 years with the Optical Society of America (OSA), initially as director of meetings and conferences, and later as part of OSA's marketing program in its development and business strategies department. The focus of her work with APS is to assist in maintaining the Society's non-member subscriptions.

Barbara Hicks

Suzanne Otwell

A graduate of Smith College, Otwell came to the APS from ASPEN, a medical and scientific association. She will be supporting the APS Committee on Education and its work on women's issues through the APS Committee on Status of Women in Physics.

IN BRIEF

Townes Receives Annunzio Award

Charles Townes

In October, the second annual $100,000 Frank Annunzio Award was presented by the Christopher Columbus Fellowship Foundation to Charles Hard Townes, inventor of the laser. Townes is a professor of physics at the University of California at Berkeley, Berkeley, CA. Townes, a fellow of the APS, received the APS Plyer Prize in 1997 and the Nobel Prize in Physics in 1964. The laser was developed out of his microwave work on molecules at Bell Telephone Labs in the early 1950s. He was trying to produce a wavelength shorter than a few millimeters in order to extend his spectroscopic studies. The concept on how to accomplish this came to him early one morning in 1951 while sitting on a park bench. Townes envisioned using radiation to stimulate a molecule or atom to give up energy, thus increasing the radiation intensity. This was the invention of the MASER, Microwave Amplification by Stimulated Emission of Radiation, which was the basic idea behind the LASER which uses light amplification.

The Frank Annunzio Award is presented to a living American whose innovative thinking has had a significant and beneficial impact on society. It is named for the Honorable Frank Annunzio who served as a Member of Congress from the State of Illinois for 28 years, and was the visionary behind the establishment of the Columbus Foundation. The Christopher Columbus Fellowship Foundation is an independent Federal government agency established by Congress to encourage and support research, study and labor designed to produce new discoveries in all fields of endeavor for the benefit of mankind.

DNP Establishes Junior Investigator Program

The APS Division of Nuclear Physics and the DOE have announced the initiation of an Outstanding Junior Investigator Program to support the development of individual research programs of outstanding scientists early in their careers. Grant applications for support are invited from tenure-track faculty currently involved in experimental or theoretical nuclear physics research falling within the full range of activities currently supported by the Division of Nuclear Physics and the DOE. The deadline is November 16, 1999. For complete information see the web page at the URL http://www.er.doe.gov/production/grants/fr99_25.html or contact Dr. Dennis G. Kovar, Division of Nuclear Physics, SC-23 (GTN), U.S. Department of Energy, 19901 Germantown Road, Germantown, Maryland 20874-1290. Telephone: (301) 903-3613, Fax: (301) 903-3833.

APS Division Gets Off Its "High" Horse

The APS Division of High Polymer Physics — the second-oldest division within the Society, having been established in 1944 — has voted to change its name to the APS Division of Polymer Physics (DPOLY). According to Andrew Lovinger (National Science Foundation), the division's councillor, the use of "High Polymer" in the division's name stemmed from the original German terminology for those new materials whose high molecular weight was responsible for their unique properties. [A low molecular weight polymer would have the properties of a liquid or a wax.] However, over the last few decades, the high molecular weight aspects of polymers have been taken for granted, and a new term, "oligomer," is used to describe low molecular weight polymers, making the modifier "high" redundant. Also, the terminology "led to the natural question of whether polymers have high physics and low physics, or variants thereof," says Lovinger. "A majority of the division members felt that a change of name would not only more accurately reflect the interests of the division, but would attract additional membership." The division members voted for the name change and the APS Council has approved it last May.

Physics In Popular Culture

Physics has been making cameo appearances in mass media culture during the APS Centennial year. In September, an episode of Jeopardy! included a category of questions on "A Century of Physics," which even mentioned the APS by name. And novelist Thomas Harris' new thriller, *Hannibal* — the sequel to his best-selling *Silence of the Lambs*, the film version of which won several Oscars in 1991 — contains a surprising reference of its own. On page 263 of the hardcover version, FBI agent Clarice Starling is attempting to track serial killer Hannibal "the cannibal" Lecter by cross-checking new subscriptions to various cultural journals Lecter has subscribed to in the past. The only one mentioned by name? The *Physical Review*.

festival profile

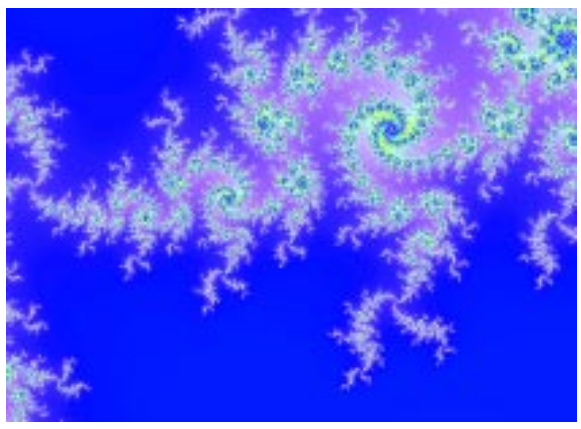
Exploring Our Fractal Universe

Richard Voss

The lights are dimmed in the auditorium at the Atlanta College of Art, and Richard Voss is playing a simple melody for the audience. But unlike traditionally composed music, this melody was generated by a computer, and is based on the fluctuations of 30 years of IBM stock prices. Voss, who is in town for the APS Centennial meeting, offers it as an aural representation of Brownian motion as part of his scheduled lecture on fractal patterns in modern culture.

A professor of physics and mathematics at Florida Atlantic University's Center for Complex Systems and Brain Science, Voss specializes in scientific computer graphics and the application of fractals not only to the natural sciences, but to art, music, literature, the stock market, cancer cells, and even the organization of base pairs of DNA. "Mandelbrot's mathematical language of fractals has revolutionized the application of geometric constructs in the sciences, and drastically changed the image of mathematics," he says. "Fractal geometry and chaos theory provide new tools and unifying concepts that bridge the traditional boundaries between science, art and finance."

Voss earned a PhD in condensed matter physics from the University of California, Berkeley, in 1975. He joined the IBM research division that same year, and found himself working closely with



Fractal images from Sprott's Fractal Gallery website: http://sprott.physics.wisc.edu/fractals.htm

the "father of fractals" himself, Benoit Mandelbrot, who first coined the term in 1975 to describe patterns or objects that exhibit similar patterns and structures at different size scales.

Certain fractal geometries exist only in the abstract world of mathematics, but Mandelbrot, Voss and others have found that many fractal patterns provide useful models for the irregular shapes found in nature, which don't follow traditional Euclidean geometries of perfectly regular circles and squares. "The structures we find in the natural world, going from the smallest microscopic scales to the largest intergalactic scales, are mimicked in the structures we see at human scales on Earth," says Voss. "If you want to understand, simulate and ultimately manipulate nature, you need to understand its language, and the language of nature turns out to be mathematics."

It was during the early period of his career — beginning when he was still a graduate student — that Voss discovered that a wide variety of music from different historical periods and cultures followed the same patterns as many natural phenomena, illustrated by the melody line generated by IBM stock prices. In music, this enables one to make a reasonably accurate guess as to what the next note might be in a given piece of music; it can also be used to generate music. Voss' early work has given rise to a proliferation of "composers" of fractal music, using specially designed software to generate the same types of feedback processes used to create fractral images.

The same concept can be applied to the visual arts. In the 1980s, Voss analyzed ancient Chinese landscape paintings from various historical periods at the request of James Watt, curator for Asian art at New York's Metropolitan Museum of Art. He determined the dimension of brush strokes in each painting, and found that those considered superior by art historians (the earlier landscapes) had fractal dimensions comparable to those of typical coastlines: between 1.25 and 1.33. In fact, the difference between the fractal dimensions of the earlier and later paintings turned out to correspond to sociological changes of the time. The early landscapes were done by painters working away from urban areas in the countryside, and hence their work involved objects repeated at different sizes, one of the defining characteristics of fractals. In contrast, the later paintings were done by court artists living in urban areas, and involved brush strokes that were simpler and smoother; the paintings were more of an abstraction of natural objects and struck Watt and his fellow art historians as being much less interesting.

The fact that human beings are drawn to objects that exhibit a specific fractal dimension is not surprising to Voss, or others working in his field. Voss conducted a study with perceptual psychologist Bernice Rogowitz, in which subjects were shown randomly generated fractal cloud patterns and asked to indicate in which cases they perceived objects in the pictures. He found that subjects saw more objects in those patterns with fractal dimensions corresponding to those found in nature. To Voss, this is suggestive of a particular sensitivity for fractal patterns in the human perceptual system, which he does not find surprising. "The human perceptual system evolved in nature, which exhibits many fractal patterns," he says. "We live in an irregular world in time and space that is very much at the boundary between predictable and unpredictable behavior."

However, Voss cautions against attaching too much importance to such measurements of fractal dimension, which can be a difficult property to pin down accurately because of the infinity of different shapes that can be analyzed within any given image. "So specific measurements — including those I have made — need to be taken with a grain of salt," he says.

In 1995 Voss left IBM and joined the Center for Complex Systems and Brain Science at Florida Atlantic University. His recent work involves applying fractal analysis to financial variables, such as seeming randomness in stock price patterns, as well as to digital mammography

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OPINION

VIEWPOINT...

International Collaboration: Cost Effective or a Give-Away?

by Irving A. Lerch, APS International Affairs

It's estimated that from 70% to as much as 80% in the expansion of our economy is technology-driven, derived from the most productive system of scientific innovation in the world. This is also true of our national security. Science is indispensable to the development and maintenance of the nation's arsenals. The Department of Energy's Nuclear Stockpile Stewardship Program is central to the safety and reliability of American nuclear weapons and to our hope for a worldwide ban on nuclear tests. But this program will fail without a continuing intense development effort based on cutting-edge science. And a great deal of the science needed is being pursued in fundamental non-weapons-related research around the world.

Science expresses the collective intelligence of humankind and it cannot be impounded by any nation. As is true of the world's economy, so is science global. Any impediment to the exchange of ideas serves only to isolate and degrade both international and domestic inquiry. But what are we to make of the return to the U.S. from its international S&T investments over the years?

Many of you may be familiar with the 1997 Rand Corporation Study by C.S. Wagner entitled, *International Cooperation in Research and Development: an Inventory of US Government Spending and a Framework for Measuring Benefits*. The study reports that in FY95, U.S. Government support for international cooperation and development exceeded $3.3 billion. This constituted about 4.5% of the total annual federal research and development budget. Of this, three-quarters goes directly to support research collaborations. Why do we spend so much on international collaboration? Wagner enumerates four reasons:

- scale of equipment or investment is large
- project is global
- unique expertise is located elsewhere
- mission of funding agency is to support international cooperation

I will add one other element: Self-organized collaborations yield prodigious increases in productivity for the core activity, member scientists and cooperating institutions.

Irving A. Lerch

Let's look at how we distributed these funds. The bar graph below summarizes the contributions by agency. Setting aside NASA, most of the funds are contributed by DoD, US AID, NSF and DoE (this would be rearranged today if we account for the DoE and NSF contributions to the CERN Large Hadron Collider project). The inset graph illustrates the disciplines being supported (excluding the international space station).

It is certainly easy to point to the importance of the geological sciences, physics, biomedicine and materials engineering to our national interest. But while the study develops a framework for assessing the impact on national priorities in science and technology, it does not answer the question of whether the return on investment is warranted. The largest investments — excluding the space program — are in support of national security.

If we ask ourselves what's at stake in this debate over the value of our investments in international cooperation, we can make a relatively simple back-of-the-envelope calculation. In a recent study of organizational complexity, Barbara Drossel of the University of Manchester invoked a model for productivity dependent upon the numbers of partners in a group and impediments to communication. Drossel assumes that group productivity per number of cooperating individuals increases as the size of the group but is depreciated by the costs of maintaining connectivity within the group. This yields a very simple model where the productivity gain of a group per member is proportional to the numbers of members and is reduced by the square of the numbers of members. So long as the cost of maintaining the group is very much smaller than the costs of communication, group productivity will climb as members are added, eventually reaching a peak and plunging negative as more and more of the group's resources go into maintenance.

As the cost of maintaining the group

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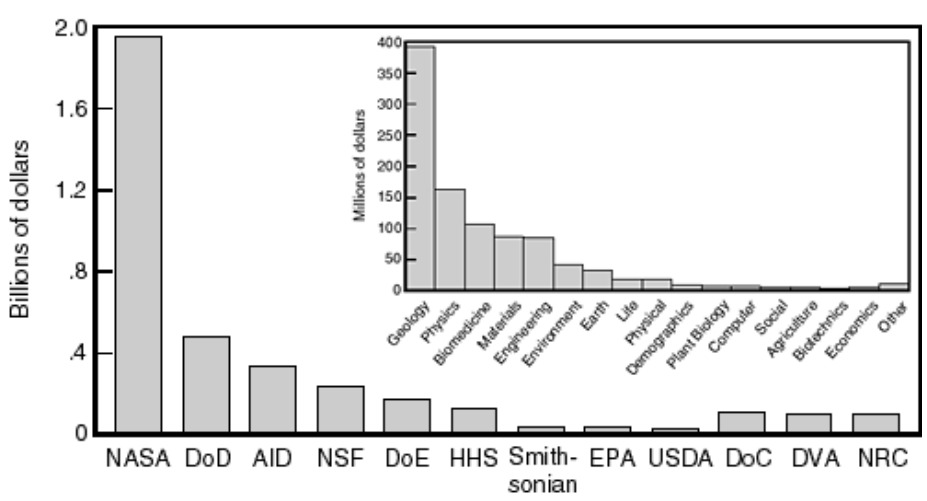

LETTERS

Happer to Remain on Princeton Team

In a letter to *APS News*, Dan Kleppner pointed out that a recent article on MRI rare gas imaging had failed to mention that this new and valuable technique was conceived and developed by William Happer of Yale University. It falls to me to correct the corrector: Will Happer is a member of the Physics Department of Princeton University and we have no intention of trading him to Yale!

Curtis G. Callan, Jr., *Princeton University, Princeton New Jersey*

Readers Reply to Chodos Regarding Foreign Students

In his back page article (*APS News*, October 1999), Alan Chodos claims that "the ability to change this [perceived shortage of American physicists] rests very little with professors in universities." But professors can do a lot, because declining interest in physics stems largely from faculty disinterest in teaching. The hiring, pay, promotions and tenure of essentially every faculty member at PhD-granting departments is based nearly exclusively on research. Most departments are eager to hire promising researchers, regardless of teaching skills. This imbalance has implications for K-12 education, for congressional and public attitudes, and for the much-lamented problems of physics. Here at the University of Arkansas, we have demonstrated that attention to students can have big payoffs. We have added two new applied BS tracks geared toward immediate employment, broken our large introductory course into smaller sections that combine lecture and lab, added a BA physics degree for students headed for careers in such non-physics fields as business and law, expanded our course for non-scientists, added two applied interdisciplinary MS programs and an MA degree for teachers, and paid greater attention to teaching and mentoring. The result? Physics course enrollments are up, the number of physics majors is up, and the physics baccalaureate graduate rate is up from an average of 2.5 per year during 1990-1997 to 12 in 1998, 13 in 1999 and 16 on track for 2000.

Art Hobson, *University of Arkansas*

When APS was founded at the turn of the last century, Europe was the world center of physics. Americans went to Europe to learn physics, and the shift to America was the result at least in part of mass immigration of European physicists to the US in the 1930s. Thus the internationalism of physics has been one of its characteristic, proud features and great strengths, and Americans have learned more than they have taught. Today, America is a magnet for foreign physics students in part because of the wealth of federal funding available for physics. It is very hard, therefore, to understand why Chodos expects increased federal funding to shift the national composition of physics students in favor of Americans. And it is not obvious that such a shift should be engineered as a matter of policy. Once we start down the road of national selectivity in science, we move in the direction of quotas and other forms of restriction, such as characterized medical school admissions in the US in the 1930s, and which now are thankfully behind us. Assuming that to first approximation national groups contribute to the pool of physics talent in proportion to their numbers, it is reasonable that students of Asian origin should be particularly numerous. We should be grateful that they favor American schools as much as they do and that so many remain in this country. Our need for scientific manpower is such that currently 55,000 persons with special skills are exempted from our immigration quotas. In World War II, we learned from experience with nationals of Japanese origin that national origin alone should not be a test of security risk, while native-borns like Aldrich Ames and the Walkers did us incalculable damage. We need better tools for credibility assessment in security investigations — not a xenophobic manpower policy.

Lawrence Cranberg, *Austin, Texas*

In his article concerning a shortage of American-born physicists for national security projects, Alan Chodos has ignored an obvious source of talent - those of us who were working for the national security at the national labs and other federal and private laboratories but were laid off or forced into early retirement at the conclusion of the SDI program. The question that occurs to me, however, is do we really need another large national effort on behalf of national security?

Bill P. Curry, Ph.D., *EMSciTek Consulting Co.*

New DOE Polygraph Rules Don't Protect National Security

The Department of Energy's proposed new polygraph policy should be of concern to many physicists. All APS members in particular should realize that polygraph screening has no theoretical foundation and is without validity; anyone can be taught to beat this type of polygraph examination in a few minutes. Any spies at our national laboratories will take those few minutes and more to learn to beat the polygraph. The following sources should make this clear:

Drew C. Richardson, testimony to the Senate Committee on the Judiciary, http://www.nopolygraph.com/drewtest.htm

Charles R. Honts, "Counterintelligence Scope Polygraph Test Found to be Poor Discriminator," *Forensic Reports*, 5 (1992), pp. 215-218.

Scientific Validity of Polygraph Resting: A Research Review and Evaluation — A Technical Memorandum. Washington DC: U.S. Congress, Office of Technology Assessment, OTA-TM-H-15, November 1983.

David T. Lykken. *A Tremor in the Blood: Uses and Abuses of the Lie Detector.* 2nd ed. New York: Plenum, 1998.

By substituting cheaper polygraph exams for more expensive background investigations, the DOE is shirking its duty to protect America's atomic secrets. The proposed rules fail to protect both national security interests and employees, and I urge the DOE to rescind its proposed polygraph rules and to use its discretionary authority to halt all polygraph screening of DOE and contractor employees. For an account of my personal experience with the polygraph — I was falsely accused of being a spy — see http://www.nopolygraph.com/captain_jones.htm

George W. Maschke, *University of California, Los Angeles*

OPINION

Conceptualizing a New Degree

by Sheila Tobias

Beginning in the 1990s, concern began to be expressed as to the underenrollment of university students in physics. In the U.S., where university students can switch in and out of majors throughout their course of study, failure to recruit is compounded by failure to retain. U.S. colleges and universities have lost 16% of their first-degree physics graduates in the last five years (24% in the last 10 years), dropping from a nationwide annual graduating cohort of 4,600 to 3,800 — a 40-year low — compared to the production annually of 78,000 engineers.

In fact, fewer than one-third of U.S. physics majors actually become "physicists" (as defined by the profession). Research findings indicate that students do not choose science in general, physics in particular, because of "narrowness of study" and "inflexibility" as regards future employment. Given these findings, perhaps a physics curriculum designed to prepare students for further physics study is not the most appropriate curriculum for the rest. Not just the teaching, textbook and laboratory, but the physics curricula are being increasingly subjected to review. Supported by national funding and by one another, we now have a large number of physicists — even Centers for Physics Education Research — dealing with the "best practices" in the teaching of physics and the training of physics instructors, as well as the productive uses of "project-based teaching," "workshop physics," and "peer instruction."

But is this enough? Will improved pedagogy be sufficiently attractive to win back the physics student who likes and does well at physics, but isn't inspired by the career options currently available? Some of us who care both about the continued health of physics and about the lack of physics-trained professionals populating other fields (e.g. banks, Foundations, government) think that, in addition to improvements in teaching, some altogether new graduate degree programs are called for, leading to careers related to physics but not circumscribed by physics and its immediate applications. Those involved in these new degree programs are calling them "Professional Masters" intending therewith to convey their equivalence (if not congruence) with the MBA and LLD degrees.

It is easier by far to create new programs within existing degree structures in higher education than to create new degrees. New programs certainly have their challenges. They often involve wholly new techniques or new applications of old techniques. They challenge the notion of who is the "expert" in a changing field, one in which no "expert" received his or her degree. And quality control has to be imaginatively reinvented when the lines between disciplines are blurred. Finally there is the issue of pedagogy: how is one to teach a new subject?

Though often stimulated by the pressure of emerging fields, the creation of new degrees is not an inevitable consequence of new discoveries or new research directions. In my view, a new degree has to have its own dynamic and rationale to be supported by higher education administrators and their stakeholders. Thus, the new professional MS degree in the sciences (and mathematics) is not to be construed as just a way of accrediting or institutionalizing or allocating scarce resources to one or more emerging fields. Rather, it is a means of providing and legitimizing some post-baccalaureate alternatives for science and mathematics majors who don't wish to do medicine or engineering, or pursue a research PhD, but do not wish to leave science altogether.

Until now, these students have had nowhere to go, except directly into industry where, as terminal BS or BA degree holders they are housed in research labs as techies. There is of course the MBA or law option. But for many of the students we are eager to serve, such post-graduate options cause them to have to reinvent themselves as law or business students, and to compete with students who, while not well-schooled in mathematics or science, are able to compete with them in the arts of advocacy and/or marketing.

The Sloan Foundation — along with the Keck Foundation, the mathematics community, and local initiatives at a few dozen universities — supports the new professional master's degree with hopes of positively impacting the science/math pipeline in a number of ways: seed reform in graduate education more generally; keep non-research oriented students in the major; provide a cadre of science-trained professionals useful to business, industry and government; and bring more science-trained people into the power centers which tend to be overpopulated with professionals from the law and finance communities.

Thus, the professional MS in science and mathematics is characterized not only by new subject matter, but also by new pedagogies and new means of evaluating applicants for admission and matriculation. The new professional MS degree programs are not identical. Some involve an emerging new field, such as bioinformatics; others interdisciplinary study, such as computational sciences; still others, science/mathematics "plus" business, law, organizational theory and communication. New pedagogies are also being discussed, such as case studies within a modular schedule at the Keck Graduate Institute; a lab rotation through a variety of cutting-edge research fields at the University of Arizona; and, at Michigan State University, a series of "basics for business" weekend short courses tailor made for the background and mindset of science/mathematics students.

Like the MBA, which took nearly 40 years to sell to students and employers, these programs must be packaged and sold. What we are after is a high-level education in the science/mathematics underpinnings of today's and tomorrow's technologies, one that will offer graduates flexible careers at the interface of R&D, product development, regulatory affairs, intellectual property issues, marketing, finance and management. Let us hope students will perceive these opportunities the way we do and that employers will provide innovative career pathways once they are in the work force.

Sheila Tobias is the author or co-author of seven books on the subjects of mathematics and science teaching and learning, among them ***They're Not Dumb, They're Different*** *(1990),* ***Breaking the Science Barrier*** *(1992), and* ***Rethinking Science as a Career*** *(1995). A version of this article appeared in the November 1999 issue of the European Journal of Physics. Information about Sloan-sponsored professional MS programs can be found online at www.ScienceMasters.com.*

zero gravity

The 1999 Ig Nobel Prizes

The 1999 Ig Nobel Prizes, presented for achievements that "cannot or should not be reproduced," were awarded at Harvard's Sanders Theatre on September 20 before 1200 spectators in a ceremony filled with hijinks, paper airplanes, and tea bags. The Prizes were physically handed to the winners by genuine Nobel Laureates William Lipscomb (Chemistry '76), Dudley Herschbach (Chemistry '86), Sheldon Glashow (Physics '79), and Robert Wilson (Physics '78) before a paper-airplane-throwing audience of 1200 people.

Eric Workman

Ig Nobel 1999, as seen from a vantage point behind the winners and authority figures on stage.

The event was produced by the science humor magazine *Annals of Improbable Research* (AIR), and co-sponsored by the Harvard Computer Society, and the Harvard-Radcliffe Science Fiction Association. The evening also featured numerous tributes to the theme of "Heredity," including a parade of descendants of famous scientists, and a mini-opera (about human cloning) starring the Nobel Laureates and millenial mezzo-soprano Margot Button. Sheldon Glashow was the prize in the annual Win-a-Date-With-a-Nobel-Laureate Contest. The event was televised live on the Internet. To see a video recording of the entire ceremony, go to the web site http://www.ignobel.org

SOCIOLOGY: Steve Penfold, of York University in Toronto, for doing his PhD thesis on the sociology of Canadian donut shops.

PHYSICS: Awarded jointly to: Dr. Len Fisher of Bath, England and Sydney, Australia for calculating the optimal way to dunk a biscuit …and to… Professor Jean-Marc Vanden-Broeck of the University of East Anglia, England, and Belgium, for calculating how to make a teapot spout that does not drip.

LITERATURE: The British Standards Institution for its six-page specification (BS-6008) of the proper way to make a cup of tea.

SCIENCE EDUCATION: Awarded jointly to: the Kansas Board of Education and the Colorado State Board of Education, for mandating that children should not believe in Darwin's theory of evolution any more than they believe in Newton's theory of gravitation, Faraday's and Maxwell's theory of electromagnetism, or Pasteur's theory that germs cause disease.

MEDICINE: Dr. Arvid Vatle of Stord, Norway, for carefully collecting, classifying, and contemplating which kinds of containers his patients chose when submitting urine samples.

CHEMISTRY: Takeshi Makino, president of The Safety Detective Agency in Osaka, Japan, for his involvement with S-Check, an infidelity detection spray that wives can apply to their husbands' underwear.

BIOLOGY: Paul Bosland of The Chile Pepper Institute, at New Mexico State University, Las Cruces, New Mexico, for breeding a spiceless jalapeño chile pepper.

ENVIRONMENTAL PROTECTION: Hyuk-ho Kwon of Kolon Company of Seoul, Korea, for inventing the self-perfuming business suit.

PEACE: Charl Fourie and Michelle Wong of Johannesburg, South Africa, for inventing an automobile burglar alarm consisting of a detection circuit and a flamethrower.

MANAGED HEALTH CARE: The late George and Charlotte Blonsky of New York City and San Jose, California, for inventing a device (US Patent #3,216,423) to aid women in giving birth — the woman is strapped onto a circular table, and the table is then rotated at high speed.

Viewpoint, *continued from page 4*

decreases from 5% to 9% of the productivity gain parameter, the maximum group productivity declines by a factor of 3 and the optimum group size declines from 14 to about half. We can generalize this model to examine the combination of groups to form larger collaborations of "supergroups." Using this model to examine the behavior of interacting groups we find that collaborations provide enormous increases in productivity. Over a broad range of small group's productivity and connectivity parameters, the putative gains in productivity of the full collaboration can be impressively large. In fact, calculations for larger numbers of collaborating groups imply that rather large gains can be achieved for modest investments to bring these groups together. This model may be further generalized to higher-order collaborations of groups of supergroups. Thus, research groups, institutional collaborations and regional intergovernmental organizations may be examined.

We have a long way to go before we can confidently assess the likely gains and costs of maintaining an international collaboration for all but the largest projects. But such assessments are possible and the early results support the economic foundations for vigorous international scientific collaborations.

An expanded version of the article, including references, can be found in the December 1999 *APS News Online* at www.aps.org under the *APS News* button.

Irving Lerch is the APS director of international scientific affairs.

INSIDE THE BELTWAY

A Washington Analysis

Sinking the Test Ban Treaty

by Michael S. Lubell

Politics generally follows a well-defined set of rules, but when hatred, mistrust and partisanship dominate the scene, as they clearly have in recent months, those rules get washed away like tiny grains of sand in a pounding surf.

The demise of the Comprehensive Test Ban Treaty bears stark testimony to the radioactive cloud that hangs over our nation's capital today. Here's the inside story. Judge for yourself.

For more than two years, Republicans, led by Senate Foreign Relations Committee Chairman Jesse Helms (R-NC), bottled the Test Ban Treaty up by refusing to hold hearings.

For more than two years, the White House studiously avoided wooing GOP internationalists like John Warner (R-VA), Pete Domenici (R-NM) and Richard Lugar (R-IN). Instead of carefully establishing a broad base of public advocacy for the treaty, as President Bush did for many months before he proceeded with the Persian Gulf War, President Clinton sniped at treaty opponents almost whimsically, as the political climate dictated.

Conservative Republicans, for whom hatred of the President has become mantra, sat back waiting patiently for the opportunity to humiliate him. Their chance came in October.

Scroll back to early September, when the Senate returned from its summer recess. With Helms stymying all attempts by Foreign Relations Committee Democrats to bring the treaty up for consideration, Ranking Member Joseph Biden (D-DE) took to the Senate floor, threatening to tie up business until Republicans agreed to consider the treaty.

Byron Dorgan (D-ND) joined the fray, and as the rhetoric became more rancorous, Senate Majority Leader Trent Lott (R-MS) sent out a clear signal that he was prepared to bring the treaty up for an immediate Senate vote, one that was guaranteed to generate far fewer than the 67 supporters needed for ratification.

Democrats can count noses as well as Republicans. So Senate Minority Leader Tom Daschle (D-SD) stepped in with a promise to call off the attack dogs if Lott withdrew his threat to schedule a vote. Reliable sources inside the ranks of the Senate Democrats reported that the assault on the GOP had been a carefully orchestrated political maneuver. The treaty, according to these sources, would not hit the policy agenda of either party until the spring of 2000, at the earliest.

With the tacit cease fire between the warring Senate factions in place, Capitol Hill debate on the treaty fizzled out. But,

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Physics Nobel Laureates Support Comprehensive Test Ban Treaty

The APS spoke out in October in support of the Comprehensive Test Ban Treaty (CTBT). APS President Jerome Friedman organized a letter signed by 32 physics Nobel Laureates, calling the treaty "central to future efforts to halt the spread of nuclear weapons." Their sentiments were echoed in the *New York Times* on October 8 by world leaders Jacques Chirac (France), Tony Blair (England) and Gerhard Schroder (Germany). The APS Council statement on the Comprehensive Test Ban Treaty was issued almost three years ago. Despite such efforts, the U.S. Senate voted against the CTBT (48-51) on Tuesday, October 12. The text of the APS Council statement is below.

"On September 10, 1996, the United Nations overwhelmingly approved the Comprehensive Test Ban Treaty (CTBT), a treaty ending all nuclear testing, of any yield, at any location, for all time. The United States, all other declared nuclear weapon states, and a growing majority of the world's nations have now signed that treaty. Although the date at which the CTBT will enter into force is not yet certain, the treaty is of extraordinary importance to the United States and to the future of all humankind.

"The CTBT, the culmination of over 40 years of effort, ends the qualitative arms race among the nuclear states and is central to future efforts to halt the further spread of nuclear weapons. The promise to negotiate and put into force a CTBT was an essential pre-condition to achieving an indefinite extension of the Non-Proliferation Treaty (NPT) in May 1995. Ratification of the CTBT will mark an important advance in uniting the world in an effort to contain and reduce the nuclear danger.

"Having been the first country to develop nuclear weapons, having been a major participant in the nuclear arms race of the Cold War, and having played a leadership role in the NPT extension and the CTBT negotiations, it is appropriate and imperative that the United States ratify the Comprehensive Test Ban Treaty at the earliest possible date. The Council notes that detailed, fully informed technical studies have concluded continued nuclear testing is not required to retain confidence in the safety and reliability of the remaining nuclear weapons in the United States' stockpile, provided science and technology programs necessary for stockpile stewardship are maintained. This conclusion is also supported by both the senior civilian and military officials responsible for US national security.

"The Council of the American Physical Society, representing 40,000 academic, industrial, and laboratory physicists, endorses the CTBT, including its extensive technical and procedural provisions to verify compliance with treaty requirements."

An excellent analysis of the pros and cons of the CTBT was published by Jeremiah Sullivan, University Illinois Urbana-Champaign, in the March 1998 issue of *Physics Today*. This article, plus others on CTBT, can be accessed through the APS server at www.aps.org/public_affairs/ctbt.html.

MEETING BRIEFS

Four Corners Section, October 1-2, Tucson, AZ

Photo courtesy of Alaina Levine

Harry Lustig

The APS Four Corners Section held its second meeting at the University of Arizona in October, featuring contributions from all fields of physics. Friday afternoon's plenary session featured Marlon Scully of Texas A&M University, speaking on Bose-Einstein condensates and their analogy to laser phase transitions, followed by a tour of the University Mirror Laboratory. The banquet Friday evening was followed by a public lecture on cosmology and new evidence for the acceleration of the expansion of the universe by Robert Krishner of Harvard University. Other highlights included a lecture on the science behind the popular TV series "Star Trek" by Andre Bormanis, a consultant on the series. Harry Lustig, APS Treasurer emeritus, provided a comprehensive account of the founding and evolution of the APS since 1899 as part of the Centennial celebration. Saturday afternoon's plenary session featured speakers from each state in the section, covering a wide range of topics, including in-situ microscopy of the growth of quantum dot islands, statistics of the cosmic density field, solar system studies, and the origin of universal scaling in biology from molecules and cells to whales.

Ohio Section, October 8-9, Dayton, OH

The APS Ohio Section held its annual fall meeting at Wright State University in Ohio in October, hosted jointly with the Air Force Institute of Technology. The four lectures focused on the history of various physics disciplines in honor of the APS Centennial and the 60th anniversary of the Ohio Section. On Friday afternoon, Norman Ramsey of Harvard University spoke on the history of atomic and molecular beams, along with Lawrence Slifkin of the University of North Carolina who summarized the history of defects in solids. They were followed by a special social hour and a special Centennial display featuring a collage of photos on early educational physics apparatus taken by Kenyon College's Thomas Greenslade, who was also the after-dinner banquet speaker. Saturday morning's plenary session featured lectures by Nicolaas Bloembergen of Harvard University on the last century in nonlinear optics, and Charles Slichter of the University of Illinois on the history of magnetic resonance.

New York State Section, October 22-23, Brockport, NY

The APS New York State Section held its annual fall meeting at the State University of New York at Brockport in October and focused on low-temperature physics and nonlinear dynamics and chaos. Friday afternoon's sessions featured lectures on aerogel and ^{3}He-introducing disorder into a superfluid; the superfluid transition of ^{4}He as a test of critical phenomena; the photophysics of silver halide nanoclusters; and the flow properties of granular matter. Kenneth Schlecht of SUNY's Chemistry Department spoke after Friday evening's banquet on the excitement of chemistry. On Saturday morning, the sessions covered such topics as nonlinear patterns in nature, swirling of superfluid films, laser cooling and Bose-Einstein condensation, and spatiotemporal organization during ventricular fibrillation.

Texas Section, October 28-30, Austin, TX

The APS Texas Section held its annual fall meeting in October at the University of Texas, Austin (UTA), featuring an opening plenary lecture on high-temperature superconductivity by Paul Chu of the University of Houston. In addition to the usual technical papers in such subfields as statistical mechanics, nanoparticles, femtosecond physics, and particle physics, Friday afternoon's program included two sessions on physics in industry, with lectures on flat panel display technologies, chemical and physical characterization of semiconductors, micro-Raman analysis applications, and making integrated circuits on spherical surfaces. In honor of the APS Centennial, the banquet speaker, David Gavenda of UTA, gave an overview of the last 100 years of physics in the state of Texas. Saturday's session on biophysics featured papers on optical spectroscopy and imaging for pre-cancer detection and the use of multiphoton-excited fluorescence as a biological probe. In a more unusual area, another Saturday session focused on forensic science, with talks on DNA analysis, drugs and toxicology, and fingerprint analysis.

New England Section, November 5-6, Waterville, ME

The APS New England Section held its annual fall meeting at Colby College in November. Friday afternoon's invited session focused on quantum technology with lectures on quantum information and coherent control, followed by a banquet with a keynote address about the Keck Observatory by Gary Chanan of the University of California, Irvine. Saturday morning began with a session on physics in elementary school education, featuring lectures on developmental issues for grades K-8 and the use of bright light-emitting diodes to teach elementary grade levels about physics. The meeting closed with a session on novel semiconductors, with talks on organic LEDs and semiconductors.

Southeastern Section, November 7-9, Chapel Hill, NC

The APS Southeastern Section held its annual fall meeting in November at the University of North Carolina, Chapel Hill, organized jointly with corresponding geographical sections from the Materials Research Society and the American Vacuum Society. Invited sessions covered such topics as physics teaching and education, imaging with hyper-polarized gases, physics with high-intensity lasers, thermo-ferroelectric materials, free electron lasers, and nonequilibrium dynamics and spatial structure. On Monday, the AVS and MRS organized additional sessions on novel materials fabrication and on fabrication, processing and characterization of wide band-gap materials. In honor of the APS Centennial, the Centennial Timeline Wall Chart was on display throughout the meeting, and Monday evening's banquet featured a lecture by Richard Voss of Florida State University on fractals and scaling in nature, culture and finance. [*Voss gave one of the popular physics talks for the Festival of Physics program held during the Centennial meeting in Atlanta in March; see page 3 for a full profile.*]

Herzog Navigates Hectic Waters of Congressional Life on the Hill

Nothing brought the reality of the world of the U.S. Congress into sharp focus for APS Congressional Fellow Antonia Herzog as much as the day she was asked to draft a rationale for an upcoming vote on the Senate floor a mere 15 minutes before the voting was scheduled to take place — concerning a proposed amendment she knew nothing about. "It's so important for members of Congress to make every floor vote," she says of what she learned from the experience. "Their schedules are basically ruled by when votes are going to occur, which is rarely certain until the last minute."

Fortunately, not every day of her fellowship year featured such last-minute scrambling, although she admits, "Things do operate constantly in crisis mode." Herzog spent the last year as a special legislative assistant in the Congressional office of Senator John D Rockefeller IV (D-WV), juggling such varied duties as preparing for hearings, organizing meetings, writing statements to be read from the floor, building support for pending legislation, and meeting with constituents and lobbyists. "It's not that you actually figure out how Congress works in a single year, but you do walk away with a much better understanding of how our country runs, and how to have an impact on the process," she says. "And that type of knowledge is useful no matter what you end up doing."


Antonia Herzog

Herzog chose to work in Rockefeller's office in part because of his longstanding interest in science and technology issues. At the time, he was the ranking Democrat on the Commerce Committee's Science, Technology & Space Subcommittee, and he is currently the ranking member of the Aviation Subcommittee. But she also admired his idealistic decision to move to West Virginia some 30 years ago, despite his privileged background, with hopes of assisting the population of this predominantly poor region. In particular, she worked on legislation involving authorized funding increases for R&D, and to streamline the technology transfer process from government labs to the private sector, although none of her projects were voted into law. "My year was about small victories, moving things forward and raising people's awareness about issues I felt were important," she says, citing R&D funding and alternative fuel vehicles as examples.

The latter is a natural extension of Herzog's long-standing interest in energy use and its impact on the environment, evidenced by her past involvement in the San Diego chapter of the Sierra Club to preserve the remaining coastal wetlands in San Diego County. As a member of Rockefeller's staff, she was able to help build co-sponsorship of a bill to promote tax incentives to promote the use of alternative fuel vehicles, and to work the legislation into the massive tax bill presented to the Senate Finance Committee. The bill was eventually vetoed by President Clinton, in large part because of the Republicans' proposed tax cut of $795 billion, but "It was neat to be involved in something that was featured on the front pages of the *Washington Post* and *New York Times* every day, even in a relatively minor capacity," she says.

Herzog came to the APS fellowship from the American Association for the Advancement of Science (AAAS), where she served as a consultant. The experience introduced her to the various issues related to the ethical, legal and policy implications of science and technology, and convinced her that she wanted to make science policy her career. She earned her PhD in physics from the University of California, San Diego. There she studied the transport properties of disordered metallic and superconducting one-dimensional wires. She also gained valuable industrial experience through a summer internship at Xerox Corporation, and held a postdoctoral research position at the Salk Institute for Biological Studies, investigating the organization of neuronal circuits for visual information processing.

Ironically, Herzog didn't use her specific knowledge of physics during her fellowship year on the Hill, but she still considers science fellows a necessary asset to Congress. "What proved crucial was having an understanding and appreciation of the scientific process and enterprise, which few of the many lawyers on the Hill possess," she says. For her part, she appreciated the network of former fellows currently working throughout government, academia and the private sector, and while her future plans are not yet final, she ultimately hopes to remain in science policy, possibly working for a non-profit science policy organization. "I firmly believe that no matter where my career may lead, this year will continue to have a profound impact on it," she concludes.

Wavelength Division Multiplexing: An Optical Communication Revolution

Donald R. Scifres

Imagine a business where user demand doubles every six months. Imagine a business that draws new users at a far faster rate than color TV, digital audio disks or VCRs. Imagine a business in which the rate of improvement in technology capability exceeds the rate of advancement in silicon integrated circuits technology over the past 25 years. This hot business is the Internet, and optical communications is the technology base that speeds the Internet information around the world.

Internet information (which is doubling every six months) travels through optical fibers. Five years ago each optical fiber carried data via pulses of light at rates up to 2.5 gigabits per second. Today, fiber optic communication systems are being installed where a single fiber has the ability to carry information as much as 200 times faster than was possible just five years ago. In fact, data rates as high as 3 terabits per second have been demonstrated.

This revolutionary capability is being achieved with a technology known as wavelength division multiplexing (WDM). WDM technology relies on the fact that optical fibers can carry many wavelengths of light simultaneously without interaction between each wavelength. Thus, a single fiber can carry many separate wavelength signals or channels simultaneously. Each of these wavelength channels can be pulsed or modulated at rates of up to 10 gigabits per second (and even 40 gigabits per second or greater in experimental systems). This capacity to wavelength multiplex signals in one fiber has led to the tremendous increase in bandwidth available to power the Internet around the globe.

Certain key products are required to make WDM possible (see Figure 1). The first is an optical fiber with very low loss in the wavelength range of 1530 to 1570 nm. A second key product is an erbium doped fiber amplifier (EDFA) which amplifies each of up to 100 wavelength channels identically every 100 kilometers in order to overcome the transmission loss in the optical fiber. Optical amplifiers operate based on the stimulated emission process. Each signal photon stimulates the emission of 10 to 100 or more identical photons from erbium atoms with electrons excited to a high-energy state through the absorption of photons at wavelengths of either 980 nm or 1480 nm. Due to stimulated emission, the amplified output signal matches both the wavelength and pulse shape of the input signal.

A third key product is the signal generating transmission laser. Each signal laser emits light at a single precisely defined wavelength. Each wavelength channel requires a separate signal-generating transmission laser. These are generally spaced on 100 GHz or 200 GHz spacings across the 1530 to 1570 nm gain bandwidth of the EDFAs. Up to approximately 100 wavelength channels provided by 100 distributed feedback semiconductor lasers can be used.

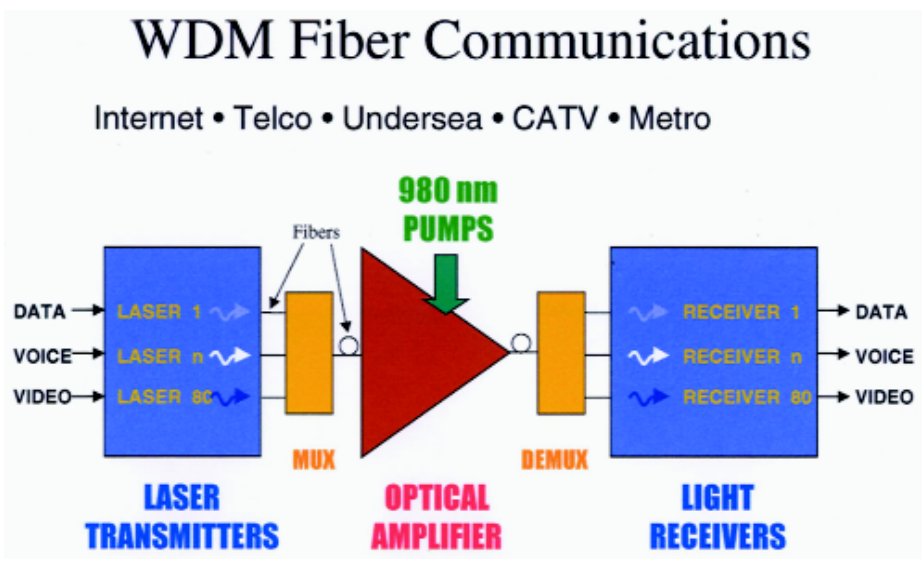


Figure 1: Key components in a WDM system.

A fourth key product is a wavelength multiplexer. This allows the insertion of all the separate wavelength laser signals to be combined into a single fiber. Narrow band dielectric stack filters are generally used to combine the separate wavelength signals into one fiber.

At the opposite end of the system from a transmission laser, a wavelength demultiplexer (which is a mirror image of the multiplexer) separates the signals into separate wavelengths of light. Each wavelength then impinges on a fifth key product, the light receiver. Generally, the receiver (which converts each wavelength channel back into electricity) consists of a PIN photodiode or avalanche photodiode and associated high-speed electronics to interface the signal into the computer or electronic network.

All of these elements combine to send information from one point to another via fibers. However, for the purpose of redundancy, reliability, capacity and cost efficiency, optical mesh networks are now being built with the ability to route wavelength channels along multiple paths to get to their final destination. In order to accomplish this, products such as Add/Drop Multiplexers allow the insertion or separation of one or more wavelengths from the many wavelengths in the fiber. This allows WDM systems to achieve the desired mesh network topology.

Finally, optical switches that allow dynamic rerouting of separate wavelength channels are now being announced. These put in sight the final goal of a transparent fiber optical network with minimal conversion of light back into electricity. Within five years, we anticipate that light will be able to flow like electricity does today through optical switches and routers to the proper network destination. As a result, low cost, high-speed data at rates up to 1 gigabit per second may over a 10-year time frame arrive at your computer terminal with the apparent ease and cost provided by today's telephone networks.


Figure 2: Shown above is a high power (1.5 W) fiber laser operating at 1455 nm. This allows amplification of 1550 nm optical signals through 20 km of standard single mode optical transmission fiber via stimulated Raman scattering (SRS). SRS amplification is expected to allow 40 Gb/sec transmission over many wavelength channels to further enhance the transmission capacity per fiber.

In order to develop these advanced technologies, there are many opportunities for cutting edge jobs with plenty of intellectual challenge. Some of the challenges involve developing new methods of amplification (see Figure 2 for Raman Amplifier), higher data transmission speeds, and smaller size, lower cost modules. All this may occur through the transition from hybrid products with discrete fibers, lenses and chips to fully monolithic products that integrate these functions onto a common substrate. In this manner, applied physicists, optical scientists, and electrical engineers will enable the wavelength division multiplexing optical communications industry to grow from a $1.6 billion market in 1997 to a $12 billion market in 2005.

Dr. Donald R. Scifres is chairman, CEO and a founder of SDL, Inc., a company specializing in fiber optics and lasers for the communications, printing and materials processing industries. Dr. Scifres has been issued over 100 patents, published over 300 technical papers and has contributed to or edited several books in the field. Dr. Scifres has also won a number of industry awards including the APS George Pake Award in 1997.

BELTWAY BRIEFS

OSTP Seeks Public Comment on Definition of Research Misconduct

The Office of Science and Technology Policy (OSTP) is seeking comment on a proposed uniform, government-wide definition of research misconduct. Public feedback to OSTP on the proposal must be postmarked no later than **DECEMBER 13, 1999.** The result of four years of consideration and extensive consultation with the primary federal R&D agencies, OSTP and the National Science and Technology Council have drafted a single definition of research misconduct that will apply to all federally-sponsored research, along with uniform guidelines for conducting fair and timely investigations into allegations of misconduct, which appeared in the October 14 issue of the *Federal Register*.

Research misconduct, as defined in the proposal, comprises "fabrication, falsification, or plagiarism in proposing, performing or reviewing research, or in reporting research results." Each of these terms is then defined in more detail. It is noted that "research misconduct does not include honest error or honest differences of opinion." A finding of research misconduct requires that "there be a significant departure from accepted practices of the scientific community for maintaining the integrity of the research record; the misconduct be committed intentionally, or knowingly, in reckless disregard of accepted practices; and the allegation be proven by a preponderance of evidence." The entire notice can be found online at http://www.access.gpo.gov/su_docs/fedreg/a991104c.html, under "Science and Technology Policy Office, Notices". [*Item courtesy of Audrey Leath, AIP Public Information*]

Report Urges State Department To Place Higher Value on S&T Expertise

In October, members of a National Research Council committee unveiled a long-awaited blueprint for improving scientific and technical expertise within the State Department. The report was requested last year by Secretary of State Madeleine Albright, in response to concerns both within the State Department and from the science community that the department lacked the capability to foresee relevant developments in science and technology and incorporate those issues into its foreign policy-making process. "As the world becomes more technologically interdependent, the trend at the State Department has been to downplay science and technical expertise. It's time to reverse that trend," said Robert Frosch, chair of the NRC Committee on Science, Technology and Health Aspects of the Foreign Policy of the United States, which issued the report. The committee's recommendations focus on raising awareness of the importance of S&T at all levels of the department. While it calls for improvement of the department's in-house S&T capability, the report recognizes the reality of budget constraints and also suggests tapping into outside expertise, including a S&T Advisory Committee, and rotating specialists from other departments and agencies. Entitled "The Pervasive Role of Science, Technology and Health in Foreign Policy: Imperatives for the Department of State," the full 111-page report can be purchased from the National Academy Press at 1-800-624-6242 or http://national-academies.org. [*Item courtesy of Audrey Leath, AIP Public Information*]

Robb Introduces Bill for New Category of High-Tech Workers

In September, Senator Charles Robb (D-VA) introduced the Helping Improved Technology Education and Competitiveness Act (HITEC Act) (S. 1645), new legislation that would establish a five-year pilot program allowing non-immigrant aliens completing an advanced degree in mathematics, science, engineering, or computer science at a U.S. college or university to apply — through an employer willing to provide a job with total compensation of $60K or more per year — for a new five year "T" or "Tech" visa. The bill was co-sponsored by democratic Senators Tim Johnson (D-SD), John Kerry (D-MA), Patrick Leahy (D-VT), Joseph Lieberman (D-CT) and Charles Schumer (D-NY). The HITEC Act requires participating companies to pay a $1000 per visa fee on applications for the T-visa and $500 for visa extensions or to change employers. The fees would be used to help fund public-private partnerships between schools and businesses to improve K-12 math, science and technology education.

Robb's bill is the latest piece of legislation introduced in response to industry lobbying to raise the H-1B visa cap on entry of high tech guest workers. A H-1B visa bill is expected shortly from Presidential-hopeful Senator John McCain (R-AZ). Senate Republican leaders have indicated that they are unlikely to move forward H-1B visa increases this year, but Senator Gramm (R-TX) and others are hopeful that measures will receive early consideration in 2000. The full text of the bill and current status can be found online at: http://thomas.loc.gov/cgi-bin/bdquery/z?d106:s.01645:

Final A-110 Revision on Access to Research Data

In October, the Office of Management and Budget issued the Final Revision of the Circular A-110 administrative requirements to comply with a law "to require Federal awarding agencies to ensure that all data produced under an award will be made available to the public through the procedures established under the Freedom of Information Act." This legislation came about through the efforts of Senator Richard Shelby (R-AL), with the support of Senate Majority Leader Trent Lott (R-MS).

The October 8 issue of the *Federal Register* has a thorough discussion of the revisions in this regulation. OMB was charged with the revision of the circular, and received over 12,000 comments since it first proposed changes in early February — an extraordinary response to an OMB regulation. The revision went into effect on November 8, 1999. It applies to grants and other financial assistance provided to institutions of higher education, hospitals, and non-profit institutions, from all Federal agencies, but not to procurement contracts. For the entire citation, see Management and Budget Office/Notices at http://www.access.gpo.gov/su_docs/fedreg/a991008c.html. *[Item courtesy of Richard Jones, AIP Public Information]*

Creating Art from Classical and Quantum Chaos

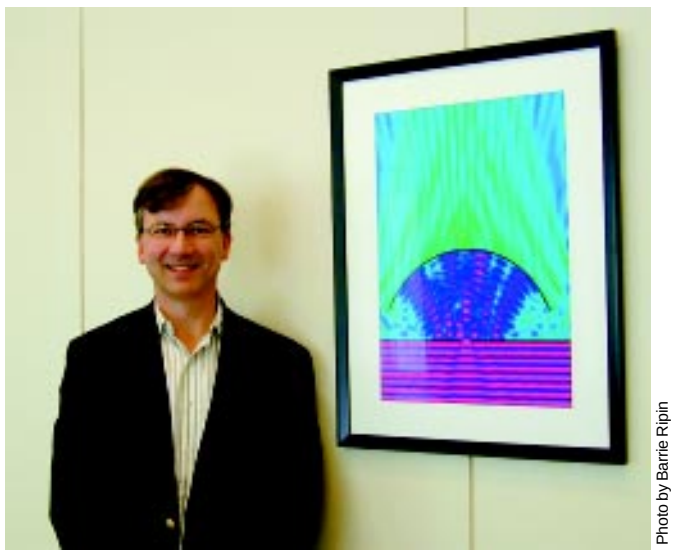


Photo by Barrie Ripin

Eric Heller stands beside one of his creations at APS Headquarters.

A series of prints depicting images derived from classical and quantum chaos is currently on exhibit in the cafeteria at the American Center for Physics in College Park, MD. Created by Eric Heller, a physicist at Harvard university, the exhibit was originally displayed as part of the APS Centennial meeting's Festival of Physics in March in Atlanta, GA. The prints were produced on an Epson 3000 inkjet printer from computer data generated in Fortran, Matlab and Mathematica.

Heller's interest in the field of chaos began with his investigation of standing quantum waves in a stadium shaped box, specifically the periodic orbits generated by a classical particle bouncing around the box. This "stadium billiard table" is shown on page 1. The image Heller is standing beside in the photo above depicts a Westervelt resonator, in which a plane wave impinges from below on a wall with a small slit. Beyond the wall is a circular mirror which causes narrow resonances to form at certain energies. Because the hole in this system is slightly off center, this resonance wavefunction has an asymmetrical shape.

Festival Profile: Fractals, *continued from page 3*

to improve the diagnostic ability of radiologists, particularly in the early detection of breast cancer. This is an area where early diagnosis has particular importance in terms of increasing life expectancy, but to date the diagnosis of breast cancer from X-ray mammograms has proven to be an extremely difficult perceptual process.

"Science is a series of approximations. What we call the great equations of science, are not something we can prove to be true. Rather, they are those we have not yet proven to be false," says Voss of his lifelong work. "Everything we do is useful, but not quite correct; it is an approximation to the real world." He often closes his lectures with a quote by Pablo Picasso: "Art is the lie that helps us see the truth." In his eyes, this is just as true of science as it is of art.

Inside the Beltway, *continued from page 6*

planners at the other end of Pennsylvania Avenue had different thoughts.

For some time, according to White House insiders, presidential advisors had been split on how to handle the treaty. One group urged delay, possibly until after the next election, when the GOP's visceral hatred of the White House occupant would be not be the dominant factor.

Another group argued that there was a political advantage to be gained by forcing a vote. This group saw the outcome as a "win-win" situation. In the unlikely event that the treaty passed, the President would claim credit. If the more probable scenario of treaty defeat became the reality, the Democrats would have a prime issue for the 2000 campaign.

A third group, bolstered by outside non-proliferation advocates, argued in favor of a vote, because they genuinely believed that they could win it, even though the White House had done little spade work and Senate Republicans were loathe to give the President credit for anything if they could help it.

Matters came to a head the last week in September. Under the questionable pretext of scheduling a bipartisan event, the White House came into possession of a letter that had been signed by thirty-two Nobel Laureates [See page 6] advocating treaty ratification. The letter, addressed to all members of the Senate, had not been released, pending Senate Foreign Relations Committee action, which had remained stalled.

On Tuesday, September 30, Senate Republicans got wind of the planned White House event featuring the Nobelists. It became the hair trigger needed for an immediate vote on treaty ratification.

Majority Leader Lott addressed the Senate early Wednesday morning, taking most of his colleagues by surprise, when he asked for unanimous consent to schedule a vote. The Democrats were in a bind. Most of them had long called for Senate action: How could they explain to their constituents that they had opposed the vote? In the end, none of them did.

As members debated Lott's motion, Joseph Lieberman (D-CT) and Pete Domenici worked furiously behind the scenes to get the vote postponed. Cancellation of the Nobel event, scheduled for the following Wednesday, was key. But the "win-win" group at the White House held sway, and the President refused to back down, according to an aide.

Predictions that the treaty wouldn't even get a majority of Senators to support it only fueled the partisan fires. When the vote finally occurred, the treaty failed 48-51, with but four Republicans voting in favor of it.

The GOP Clinton-haters had made their point, and the Democrats had their campaign issue. The treaty was the big loser.

Stanley Greenberg, a prominent Democratic pollster, observed that the White House took a huge risk in pursuing its strategy. While it is true that eighty percent of the American electorate supports the treaty, the issue is buried so far down on the public's wish list, that the campaign pay-off may be nil. Time will tell whether Greenberg's right.

APS 2000 Election Results, *continued from page 1*

CHAIR ELECT OF THE NOMINATING COMMITTEE

CURTIS G. CALLAN, JR.
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 from Princeton in 1964, and then 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 research, he has been active for many years in advising U.S. government agencies on the applications of science and technology to national security problems.

In his candidate's statement, Callan discussed the enormous changes both in the intellectual content of the science itself, and in the societal and funding context in which it lives, and the challenges these present to the APS and the physics community in general. "Finding people with the necessary qualities of intellect, energy and judgement to lead the APS, and convincing them to stand for office, is more critical today than it ever has been," he wrote. "The future health of our Society is dependent on the judgement and activism of today's Nominating Committee."

GENERAL COUNCILLORS

JIN-JOO SONG
Oklahoma State University

Born in Seoul, Korea, Song 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 was recently elected the 21st and first woman president of the Association of Korean Physicists in America. Her present research interests include nanotechnology and ultrafast phenomena, especially widegap semiconductor quantum structures, epitaxial growth, characterization, and device fabrication.

In her candidate's statement, Song cited the growing internationalization of the Society, and the continual advancement of information technology that is accelerating the development of professional exchanges to a level previously inconceivable, and prompting a reassessment of the role of the APS in fostering this growing international character. In Song's view, one of the biggest challenges the APS faces is that of making physics and physicists more relevant to society while preserving the pursuit of the most fundamental understanding of the nature of the physical universe. "I believe the APS should embrace diversification and multidisciplinary approaches in physics education with courage and conviction, for such evolution does not necessarily lead to the de-emphasizing of fundamental research in the traditional subfields known to academia, but is instead vital to the survival of physicists and physics education," she wrote. "In fact, I believe that the physics community will begin to realize that diversification is at the very root of fundamental research, and that the study of physics could not have progressed to today's levels of understanding without such diversification in the past."

PHILIP PHILLIPS
University of Illinois, Urbana-Champaign

Born in Scarborough, Tobago, Phillips received his PhD from the University of Washington in 1982. After two years at the University of California at Berkeley, he served on the faculty in the chemistry department at MIT until 1993, when he moved to the University of Illinois at Urbana-Champaign. 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. While he has worked on numerous problems such as the size and disorder dependence of the Kondo effect, bi-criticality in quantum spin glasses, and pair-tunneling in quantum dots, much of his recent efforts have been devoted to explaining the origin of the new conducting phase found in a dilute 2D electron gas.

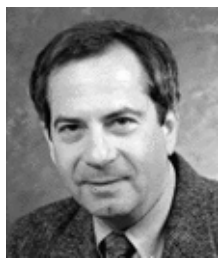
In his candidate's statement, Phillips cited three areas he believes merits particular attention by the APS, its officers and elected representatives, because of their potential for concrete action. These include the need for diversity in the physics community; the education of students to the notion that a physics major opens more doors than it closes; and a need for efficient lobbying to increase the level of research funding for condensed matter physics, particularly theory.

MARGARET M. MURNANE
University of Colorado

Murnane joined JILA and the Department of Physics at the University of Colorado in August of 1999. Prof. Murnane received her BS and MS degrees from University College Cork, Ireland, and 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. In 1996, Professor Murnane moved to the University of Michigan. Prof. Murnane's 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. She is a past recipient of the APS Simon Ramo Award.

In her candidate's statement, Murnane looked to the 21st Century and the many opportunities for physicists to impact the science and technology of the new millenium, including advances in nanoscale structures, laser manipulation of matter, and computational. She suggested the APS promote meetings in rapidly changing fields, by providing more opportunities for multi-disciplinary meetings, by advertising new discoveries and their impact on society as much as possible, and by supporting increased participation of industry to broaden career-choices for students. She also supports continuing the Society's efforts to articulate the breadth and diversity of physics, and to communicate the beauty, excitement, and impact of physics to the general public.

STUART J. FREEDMAN
University of California at Berkeley
Lawrence Berkeley National Laboratory
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, and the University of Chicago in 1987, jointly with Argonne, returning to Berkeley in 1991.

In his candidate's statement, Freedman spoke of how the role of physics in the high-tech world of the next millennium, its relationship to society, and the character of basic research are changing dramatically. He cited two challenges in particular facing the APS: public education and outreach, and globalization. "A scientifically illiterate society is totally inappropriate for the 21st century, and the APS should strengthen its resolve for effectively advocating a sensible scientific component in the education for every young American," Freedman wrote. Similarly, "Communication technologies and the emerging global economy provide us with the opportunity of creating a truly international community of scientists and scientific research, and we should take a leading role toward insuring that physics continues to develop as an international enterprise."

Nobel Prizes, *continued from page 1*

a trillionth of a second between the beginning and end of a reaction. It has also provided a way for controlling the courses of chemical reaction and developing desirable new materials for electronics. It has provided insights on the dissolving of liquids, corrosion and catalysis on surfaces (see *Physics Today*, October 1999, p. 19); and the molecular-level details of how chlorophyll molecules can efficiently convert sunlight into useable energy for plants during the process of photosynthesis.

Veltman and Zewail are fellows of the APS. Zewail was awarded the APS Earle Plyler Prize in 1993 and the Herbert Broida Prize in 1995. Although not an APS member, nonetheless, Gerardus 't Hooft received the 1979 Dannie Heineman Prize.

—Philip F. Schewe, AIP Public Information

APS Staff Serve at Local 'Soup Kitchen'

Staff donated and distributed lasagna, sandwiches, cookies and other foods to needy people near APS headquarters in Maryland this Fall.

LBL Scientists Introduce New Microscope for Characterizing Materials

Researchers at Lawrence Berkeley National Laboratory (LBL) have developed a new thumb-sized microscope that operates on the same principles as a CD-player, using microwaves rather than visible light. Dubbed a Scanning Evanescent Microwave Probe (SEMP), this unique new instrument can be used to simultaneously characterize critical electronic properties along with topography in a wide assortment of materials. Xiao-Dong Xiang, a physicist in LBL's Materials Sciences Division, described the instrument in a paper he delivered at the APS Centennial meeting in Atlanta last March.

The SEMP uses near-field microwaves to measure the electrical impedance of materials with submicron resolution — a critical property for the electronics industry. By measuring the interaction between evanescent microwaves generated off an ultra sharp-tipped probe and the surface of the material, Xiang and his colleagues can not only map electrical impedance across the face of the material, they can simultaneously map the topography of its surface, another critical factor for manufacturing chips and other electronic devices.

The SEMP's probe is connected to a high quality-factor microwave resonator equipped with a thin metal shield designed to screen out all but the evanescent microwaves from being generated at its tip. "This feature is crucial for high resolution quantitative microscopy," says Xiang. "If both evanescent and propagating microwaves had to be considered and calculated, as is the case for all other types of microwave probes, the quantitative microscopy would be impossible." The interaction between evanescent microwaves and the sample surface gives rise to a resonance frequency and quality-factor changes in the resonator that are recorded as signals. These signals can be measured, and the measurements plugged into equations that translate them into a measurement of the sample's complex electrical impedance, with a spatial resolution of 100 nanometers.

The SEMP can be used on conductors and insulators as well as semiconductors. It has applications in any situation in which there is a need to characterize a material's electrical properties as a function of electric or magnetic fields, optical illumination, or temperature variations. The basic technology has been licensed to Ariel Technologies, but Xiang and his colleagues continue to refine the device, and are currently building a low-temperature version to enable them to study superconductors.

Announcements

APS/AIP 2000-2001 CONGRESSIONAL SCIENCE FELLOWSHIP PROGRAM

THE AMERICAN PHYSICAL SOCIETY AND THE AMERICAN INSTITUTE OF PHYSICS are accepting applications for their 2000-2001 Congressional Science Fellowship Programs. Fellows serve one year on the staff of a Member of Congress or congressional committee, learning the legislative process while they lend scientific expertise to public policy issues.

QUALIFICATIONS include a PhD or equivalent research experience in physics or a closely related field. Fellows are required to be U.S. citizens and, for the AIP Fellowship, members of 1 or more of the AIP Member Societies. A stipend of up to $49,000 is offered, in addition to allowances for relocation, in-service travel, and health insurance premiums. Applications should consist of a letter of intent, a 2-page resume, and 3 letters of recommendation.

PLEASE SEE our websites (http://www.aip.org/pubinfo or http://www.aps.org/public_affairs/fellow.html) for detailed information on applying. If qualified, applicants will be considered for both programs. All application materials must be postmarked by **January 15, 2000**, and sent to: APS/AIP Congressional Science Fellowship Programs, c/o Erika Ridgeway/APS Executive Office One Physics Ellipse, College Park, MD 20740-3844.

APS MASS MEDIA FELLOWSHIP PROGRAM

Applications are now being accepted for the 2000 summer APS Mass Media Fellowships. In affiliation with the popular AAAS program, the APS is sponsoring two ten-week fellowships for physics students to work full-time over the summer as reporters, researchers, and production assistants in mass media organizations nationwide.

PURPOSE: The program is intended to improve public understanding and appreciation of science and technology, and to sharpen the ability of the fellows to communicate complex technical issues to non-specialists.

ELIGIBILITY: Priority will be given to graduate students in physics, or a closely related field, although applications will also be considered from outstanding undergraduates and post- doctoral researchers. Applicants should possess outstanding written and oral communication skills and a strong interest in learning about the media.

TERM AND STIPEND: Following an intensive three-day orientation in early June 1999 at the AAAS in Washington, DC, winning candidates will work full-time through mid-August. Remuneration is **$4500**, plus a travel allowance of up to $1,000.

Mail application materials, which must be received by **January 15, 2000**, to:

APS Washington Office
ATTN: Mass Media Fellowship Program
529 14th Street NW, Suite 1050
Washington, DC 20045

Information on application requirements can be found at http://www.aps.org/public_affairs/Media.html

Y2K MARCH MEETING TUTORIALS, WORKSHOPS & SHORT COURSES

TUTORIALS

The following eight half-day tutorials will be offered on Sunday, March 19, 2000, just prior to the APS March Meeting in Minneapolis, MN:

8:30 AM - 12:30 PM

- T1 Cellular Automata Simulations with Mathematica
- T2 High Temperature Superconducting Power Applications
- T3 Physics of Optical Communications
- T4 Biological Fluorescence Imaging

1:30 PM - 5:30 PM

- T5 Achieving High Performance in Numerical Computations on RISC Workstations and Parallel Systems
- T6 Silicon Quantum Dots: Fundamentals and Application to Advanced and Future Nanoelectronic Devices
- T7 Advanced Magnetic Resonance Technologies in New Frontiers of Science
- T8 The Changing Roles of Researchers in Industrial and Applied Physics

CAREER WORKSHOPS

Sunday evening, March 19, 6:00pm - 9:00pm, the APS will offer a free Career Workshop run by the Career Services Division of AIP.

DPOLY SHORT COURSE TO FOCUS ON POLYMER THIN FILMS

The APS Division of Polymer Physics (DPOLY) will hold a short course on adhesion and other issues in polymer thin films and coatings as part of the 2000 APS March Meeting, to be held on Saturday and on Sunday morning, March 18-19 in Minneapolis, MN. The science and engineering of polymer thin films and coatings has numerous industrial applications, including adhesives, composites, fillers, and tissue implants. The course will provide an overview of recent developments in this area, such as polymer-surface dynamics and interfacial rheology; macromolecular physics of biological surface interactions; the glass transition of thin films; simulation methods and theory; and dewetting and coating of interfaces.

See *Meeting Announcements* for more information and enrollment instructions.

Y2K Spring Meeting Deadlines

March Meeting (www.aps.org/meet/MAR00)

Abstract Submission Deadline	12/03/99
Early registration deadline	01/14/00
Receipt of postdeadline abstracts	02/04/00
Housing	02/17/00
Late Registration Deadline	02/18/00

April Meeting (www.aps.org/meet/APR00)

Abstract Submission Deadline	01/14/00
Early registration deadline	02/18/00
Housing (APS hotel blocks released)	03/31/00

Prize and Award Nominations

DEADLINE: JANUARY 18, 2000

OTTO LAPORTE AWARD

Endowed by the friends of Otto Laporte and the Division of Fluid Dynamics.
Purpose: To recognize outstanding research accomplishments pertaining to the physics of fluids.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Joel Koplik; Levich Inst T-1 M; CCNY-CUNY; 138th St & Convent Ave; New York NY 10031. Phone (212) 650-8162; Fax (212) 650-6835; email koplik@sci.ccny.cuny.edu
DEADLINE: January 18, 2000

FLUID DYNAMICS PRIZE

Supported by friends of the Division of Fluid Dynamics and the American Institute of Physics journal *Physics of Fluids.*
Purpose: To recognize and encourage outstanding achievement in fluid dynamics research.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Joel H Ferziger; Dept of Mech Engr; Stanford University; Stanford CA 94305. Phone (650) 723-3615; Fax (650) 725-3525; Email ferziger@ecoule.stanford.edu
Deadline: January 18, 2000

DEADLINE: APRIL 1, 2000

JAMES CLERK MAXWELL PRIZE IN PLASMA PHYSICS

Sponsored by Maxwell Technologies, Inc.
Purpose: To recognize outstanding contributions to the field of plasma physics.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Jeffrey Friedberg; Dept Of Nuclear Engineering; MIT; Room 24-107; Cambridge, MA 02139. Phone (617) 253-8670; Fax (617) 257-7437; Email jpfreid@mit.edu
Deadline: April 1, 2000

AWARD FOR EXCELLENCE IN PLASMA PHYSICS RESEARCH

Established with support from friends of the Division of Plasma Physics.
Purpose: To recognize a particular recent outstanding achievement in plasma physics research.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Earl Marmar; NW17-119; MIT; 77 Massachusetts Ave; Cambridge MA 02139. Phone (617) 253-5455; Fax (617) 253-0627; Email marmar@psfc.mit.edu
Deadline: April 1, 2000

OUTSTANDING DOCTORAL THESIS IN PLASMA PHYSICS AWARD

Established originally as the Simon Ramo Award and endowed in 1997 by General Atomics Inc.
Purpose: To provide recognition to exceptional young scientists who have performed original thesis work of outstanding scientific quality and achievement in the area of plasma physics.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Linda Vahala; 138 Nina Ln; Williamsburg VA 23188. Phone (804) 683-4968; Email: u1026@c.nersc.gov
Deadline: April 1, 2000

NICHOLSON MEDAL FOR HUMANITARIAN SERVICE

Sponsored by friends of Dwight Nicholson.
Purpose: To recognize the humanitarian aspect of physics and physicists.
Send **FIVE (5)** copies of the nomination package with the name of proposed candidate and supporting information to: Herbert L Berk; RLM 11.326 Dept of Phys; Univ of Texas, Institution for Fusion Studies; Dean Keaton & Speedway; Austin, TX 78712. Phone (512) 471-1364; Fax (512) 471-6715; Email: berk@peaches.ph.utexas.edu
Deadline: April 1, 2000

Announcements

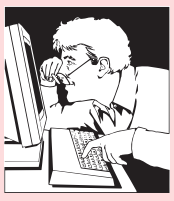
CAUGHT IN THE WEB

Notable information on the World Wide Web

March Meeting: www.aps.org/meet/MAR00
April Meeting: www.aps.org/meet/APR00
Prize & Award Recipients: www.aps.org/praw/
New APS Fellows: www.aps.org/fellowship/
Fractal Gallery: sprott.physics.wisc.edu/fractals.htm
A Century of Physics timeline: timeline.aps.org
Playground Physics: www.aps.org/playground.html
Phys. Rev. Focus: focus.aps.org
Physics Limericks: www.aps.org/apsnews/limericks.html
Amazon Books: www.aps.org/memb/amazon
100 Years of the APS - Exhibit & History: www.aps.org/apsnews/history.html
Wacky Patents: colitz.com/site/wacky.htm

MAKE SURE WE HAVE IT RIGHT!

The *2000-2001 APS Member Directory* will be compiled in January 2000. Please check your directory listing online (www.aps.org/memb) or on your latest member invoice and forward any necessary changes to coa@aps.org. Updates may also be given to a Membership Representative at 301-209-3280 or faxed to 301-209-0867. All requests should be received no later than December 17, 1999.



APS SEEKS ASSOCIATE EXECUTIVE OFFICER

The American Physical Society is seeking applications and nominations for the position of Associate Executive Officer. The primary responsibility of the Associate Executive Officer is to work with the Executive Officer to coordinate and enhance APS programs and activities. It is expected that the person selected will play a leadership role in APS efforts to communicate with the public and with APS members and act as editor of *APS News*, both paper and online versions. Other responsibilities may include the administration of APS awards and fellowship programs, working with APS divisions, sections, forums and topical groups, and initiating new programs to serve APS member needs. Qualifications for the position include a PhD in physics or a related field, extensive familiarity with the physics community, and excellent communication skills. APS offers a competitive salary and an outstanding benefits packet. For consideration, send a cover letter, resume, and professional references to Judy Franz, Executive Officer, APS, One Physics Ellipse, College Park, MD 20740, fax: 301-209-0865, email: **franz@aps.org**. For further information, don't hesitate to send an email message or call: 301-209-3270.

Discounted Auto Insurance Added to Member Benefits

The APS has entered into an agreement with GEICO, a leading auto insurer, to provide members with a preferred rate. With a current or new GEICO Preferred auto insurance policy, mention your APS membership number (listed on the first line of your *APS News* mailing label) and, in most states, GEICO will give you an extra 8% discount.* The savings will cover the cost of annual APS dues in most cases. In addition to savings, GEICO offers convenient 24-hour service from a professional representative for rate quotes, claims, or questions. When you qualify, you'll get coverage tailored to your personal needs and a choice of payment plans.

All it takes is a quick call to GEICO Preferred at: 1-800-368-2734 or a visit to their web site at: www.geico.com.

**Discount is 10% in CA, DC, and IL; 3% in NY; not available in all states. Discount is not available in GEICO Indemnity Company or GEICO Casualty Company. One group discount applicable per policy. Government Employees Insurance Co. GEICO General Insurance Co. GEICO Indemnity Co. GEICO Casualty Co. These shareholder-owned companies are not affiliated with the U.S. Government. GEICO Auto Insurance is not available in MA , NJ or outside the U.S.*

Take $100 Off a New Life APS Membership

In celebration of the Centennial, the APS has initiated a $100 discount off new life memberships between March 1, 1999 and February 29, 2000. A life membership, which ordinarily costs 15 times the regular current annual dues rate, includes a free life membership in one dues-requiring unit.

To take advantage of this special offer, look for details in your next invoice renewal packet. The offer is not valid on an existing or previously purchased Life membership. Questions may be directed to the APS Membership Department at 301-209-3280 or membership@aps.org.

Volunteers Sought for APS Initiative on Inter-American Cooperation in Physics

The APS jointly through its Office of International Affairs, The APS Committee on International Scientific Affairs (CISA), and the Forum on International Physics (FIP) is presently pursuing an initiative designed to promote increased Inter-American cooperation in physics.

As one component of the overall Inter-American physics cooperation effort, the APS is currently seeking to identify volunteers who are interested in making contacts and establishing collaborations and working relationships with physicists in Latin America and Caribbean. A list of such volunteers is now being compiled that will be available as a Directory both on the APS Web site and in a hard-copy form that will be directly distributed to physics departments in Latin America and the Caribbean.

The purpose of the new directory is to provide initial contact information that can be used by Latin American and Caribbean physicists for the purpose of identifying potential lecturers, research collaborators, teachers, students, etc. who would be willing to visit and work for varying periods of time in a host country. Naturally, any details involving partial or full support of travel and living expenses in the host country would be arranged on an individual basis directly between the prospective visitors and their hosts without any involvement on the part of the APS. Additionally, while there is an emphasis on identifying individuals with Spanish or Portuguese language skills, individuals who do not possess such skills but who are personally motivated to interact with Latin American and Caribbean physicists are still encouraged to complete and submit the form for inclusion in the Directory.

All APS members who are interested in being included in this directory of potential scientific collaborators with Latin American and Caribbean counterparts are requested to provide the following information:

FAMILY NAME _____

FIRST NAME _____ MIDDLE INITIAL _____

ORGANIZATION _____

DEPARTMENT _____ MAIL STOP _____

STREET ADDRESS _____

CITY _____ STATE _____ POSTAL CODE _____

COUNTRY _____

PHONE _____ FAX _____

E-MAIL _____

WEBPAGE URL *(IF AVAILABLE)* _____

PRESENT POSITION _____

DEGREES HELD _____

LIST YOUR AREAS OF RESEARCH AND TEACHING INTEREST AND EXPERIENCE:

FLUENT IN? SPANISH _____ PORTUGUESE _____ OTHER _____

Please return the completed form or email the information to: Michele Irwin, International Programs Assistant, Office of International Affairs; American Physical Society; One Physics Ellipse; College Park, MD 20740-3844; email: mirwin@aps.org

Y2K APS Fellowship Nomination Deadlines

DIVISIONS	
Astrophysics	05/01/2000
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THE BACK PAGE

Christmas and the Scientist in the Technological Age

by Roger Highfield

Christmas is a time for the crunch of snow, spiced wine, and tinseled trees. Christmas is a time for giving, meeting friends and feasting. Christmas is a time for carols, family gatherings, gaudy greeting cards, and all the jollity of the seasonal spirit. Christmas is also a time for science.

Chemists are hard at work in the Christmas kitchen. Experts on thermodynamics have drafted equations to help us cook turkeys to perfection, scanners have scrutinized steaming plum puddings, and pharmacologists have traced the baroque metabolic pathways of the brain to explain why chocolates can be so addictive. Meteorologists study every aspect of the snow cycle that provides a seasonal sprinkling, from the seeding of an ice crystal high in the sky to the traces of past Christmases buried deep in the snowpack. Climatologists are plundering this record to help predict white Christmases far into the future. A handful are even concocting outlandish schemes to guarantee that each and every Christmas is white. Psychologists tease out the hidden agenda of the Christmas card and what it reveals about our social status. Anthropologists hunt for the foundation of the celebration in pagan rituals that took place before the birth of Christ, during long winter nights when our ancestors feared that the sun would never return.

I have been investigating the science of Christmas for more than a decade. When I first began to take an interest in the subject, I was unprepared for the breadth and depth of the insights that would eventually emerge. Take those flying reindeer, Santa's red and white color scheme and his jolly disposition, for example. They are all probably linked to the use of hallucinogenic toadstool in ancient rituals. I can add that Santa was born with a genetic predisposition to become obese and now suffers from diabetes. He does not live at the North Pole, preferring the warmth of an island off the coast of Turkey. There, panting at his side, you will find Rosie — not Rudolph — the reindeer.

I was at first puzzled by how Santa could fly in any weather, circle the globe on Christmas Eve, carry millions and millions of presents, and make all those rooftop landings with pinpoint accuracy. The answer lies in his unprecedented research resources and expertise across a range of fields, spanning genetic engineering, computing, nanotechnology, and quantum gravity. My experience undermines the idea that the materialist insights of science destroy our capacity to wonder, leaving the world a more boring place. For me, the very reverse is true. I can still remember the day when, as a child, I first became convinced that Santa did not exist. Now, by refracting the Santa myth through the prism of science, he seems more real than ever.

I believe that science and technology can even shed a little light on a deeper question: where did Christmas come from in the first place? Peel back the wallpaper of centuries and you will find that the festival is an amalgam of influences — German, Dutch, English, American and other traditions, both religious and pagan — that emerged over the millenia. Even today, the traditional Christmas hoopla is far from a homogenous phenomenon, taking place alongside Kwanzaa, an African-American harvest holiday, and the eight-day Jewish celebration of Hanukkah. Together they constitute *the* annual celebration.

Part of the reason winter festivities went global can be found 150 years ago, at the tail end of the Industrial Revolution. It was then that the "Christ's Mass", the church service that celebrates the birth of Jesus Christ, along with a wealth of other traditions, entered the scientific age of mass communication, transport, and other technologies. This collision between ancient tradition and the age of science and technology was particularly significant in Victorian Britain where, during a single decade, there was a striking coincidence of events of significance for science and the annual celebrations.

The 1840s saw a dizzying rate of change in society due to efforts across a proliferating range of disciplines. In the world of science, there was Darwin's ideas on natural selection, Joule's work on thermodynamics, and Faraday's studies of magnetism, light and electricity. In the sister disciplines of engineering and technology, there were developments in factories, machine tools, and information technology. Babbage was hard at work on his difference engine and a web of telegraph lines spread across the nation. All the while the old certainties seemed to have been squashed flat by the steam hammer, steamboat, and steam train. The resulting turmoil in society made the traditional Christmas message of charity more relevant than ever. Emerging communications technologies, from speedy railways to the telegraph, paved the way for that message to be disseminated and homogenized for mass consumption, forging much of what we think of today as the traditional festivities.

The tumultuous 1840s also saw an important token of the rising influence of science: the birth of a specific label for the burgeoning army of individuals at work in this field. William Whewell, a polymath who was a Fellow of the Royal Society, coined the word "scientist" in earnest in his two-volume book *The Philosophy of the Inductive Sciences*. The word was of dubious legitimacy in philological terms, a hybrid of Latin and Greek, and was attacked (wrongly) as "an American barbarous trisyllable." But the pressure to put a name to this increasingly influential group was overwhelming.

At the same time that the scientist was born, an eminent and extraordinary individual, Henry Cole, decided to reduce the burden of writing Christmas greeting letters by taking advantage of another development he'd had a hand in: the introduction of the penny post in 1840. His invention, the first Christmas card, was published in 1843 and cost a shilling, the equivalent of a day's wages for a laborer. After two decades, the price fell dramatically thanks to one of the technological inventions of the day, cheap color lithography, and Christmas cards entered the mass market.

Cole regarded the card as the folk art of the Industrial Revolution, and it ultimately became the greatest popularizer of now-standard Christmas iconography, with designs ranging from bizarre characters with pudding heads to mannequins in period costume, as well as the more conventional mistletoe, robins, holly and fireside scenes. Not only were the cards printed on paper, but they were also gilded, frosted, and dressed with satin or fringed silk. Some were even made to squeak. Through the evolution of one of the card's most familiar characters, it is possible to trace the influence of scientists, engineers, and technologies on our way of life. I am, of course, referring to the many depictions of the fat man with the white beard.

A silk-fringed card published in 1888 reveals how by then, Santa had resorted to the latest communications technology to improve the links with his market. The figure shown on the card seems to be engaged in what can only be described as a conference call, listening to the simultaneous demands for presents from an assortment of children. Only the previous decade, Alexander Graham Bell had patented the telephone had made it all possible.

By the 1890s Santa had decided to give up his sleigh and reindeer, preferring to haul his gifts around by "the new monstrosity from France," the automobile. As a result of the development of the internal combustion engine, the silent night, holy night now throbs to the sound of traffic. The stillness of the snowy landscape shown on so many Christmas cards is marred by the groan of the snowplow. The search for the Bethlehem star is now obscured by a haze of photochemical smog. Another newfangled device, the wireless, appears on one 1929 Christmas card, which features a Santa apparently mesmerized by the crackling message it is receiving over the ether. Radio would become the first mass medium to reinforce the tendency for Christmas to be a festival held behind closed doors. When Santa reached for a cool soda pop in a Coca-Cola advertisement that appeared during the Christmas season of 1937, he was again a technological pioneer. The source of his refreshment was a refrigerator, even though iceboxes were still being used by most American households that year.

Santa can now be found in cyberspace. The last time I checked, there were hundreds of Santa home pages for children's email. Digitized images of Santa now scud about the web of international computer networks every Christmas. One day these images may even supplant the traditional Christmas card. However, I believe that an emailed Santa, spouting digital "ho, hos" and seasonal greetings, would still honor the spirit in which Henry Cole first dreamed up the card — as a practical way to marry mass communication and art.

Cole would be amazed and gratified by the extent to which his little invention has caught on today. A century and a half later, science is still altering the very nature and fabric of the celebrations through the introduction of new technology, whether cloned Christmas trees, the Internet, or those infuriating cards that play carols over and over again. The future of Christmas and Hanukkah in our increasingly technological age seems assured.

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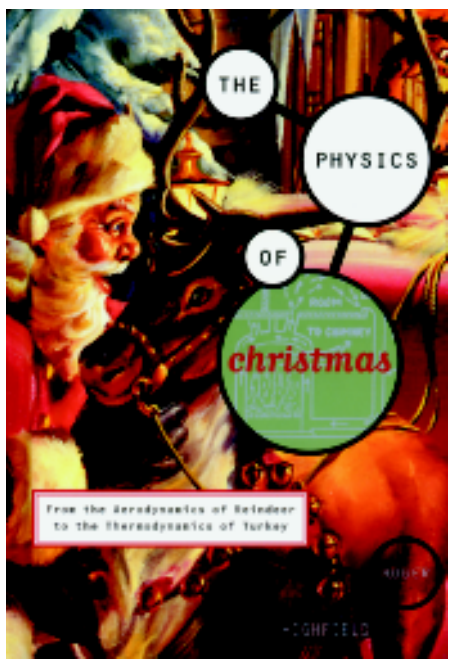

Festive Formula

For those who like to plan their Christmas in advance, here is a little formula that can reveal the day of the week that Christmas Day falls on in any year (including leap years) after 1600.

1. Write down the year you're interested in, e.g., 1998. Split this number into its century number C (19) and its year number Y (98).
2. Now divide C by 4 and keep just the whole-number part of the result, K. In this case K=19 [div] 4 = 4.75, which is rounded off to 4.
3. Do the same for Y, giving a new figure, G. [G = 98 [div] 4 = 24.5, rounded off to 24]
4. Now work out the value of D, using the formula D = 50 + Y + K + G - (2 x C)
   [D= 50 + 98 + 4 + 24 - 38 = 138]
5. To work out the day of the week, divide D by 7 and write down the remainder, R. [138 [div] 7 = 19 with a remainder of 5, or Friday] Use the following table to determine the day of the week:

   R = 0 ..... Sunday
   R = 1 ..... Monday
   R = 2 ..... Tuesday
   R = 3 ..... Wednesday
   R = 4 ..... Thursday
   R = 5 ..... Friday
   R = 6 ..... Saturday

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