APS NEWS

JANUARY 1999 THE AMERICAN PHYSICAL SOCIETY VOLUME 8, NO. 1

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2 Months to Go

APS Centennial

March 20-26, 1999
www.aps.org/centennial

Undergraduates Participate in DNP Meeting

A new program for undergraduate students debuted at the 1998 Fall meeting of the APS Division of Nuclear Physics (DNP) held in October in Santa Fe, New Mexico. Entitled "The Conference Experience for Undergraduates" (CEU), the program featured several activities designed to provide a "capstone" conference experience for undergraduate students in experimental and theoretical nuclear physics research. CEU students presented their research in two separate poster sessions, and met with members of the professional community to discuss research and graduate school opportunities.

A total of 59 students from 41 colleges and universities around the country and abroad attended, more than 25% of whom were women. Participants were selected on the basis of submitted research abstracts and statements of their individual contributions to the larger research effort. Travel and lodging awards were granted to many, funded in part by the National Science Foundation and the Department of Energy.

The CEU program included several activities intended to provide students with a broader conference experience. On one afternoon students attended a reception hosted by DNP Chair Stuart Freedman, where they met with several officers and members of the DNP community. Eric Norman of the Lawrence Berkeley National Laboratory delivered a keynote address entitled "What's Hot In Nuclear Physics," summarizing topics of current research interest, such as nuclear astrophysics and cosmology, the Standard Model, solar neutrino experiments, searches for the quark gluon plasma, and studies of nucleon substructure.

Students also attended the evening DNP reception, followed by a special memorial presentation: "David Schramm: Celebration of a Life in Science." On Thursday and Friday, the University of North Carolina and Michigan State University, respectively, sponsored lunches for the students, during which they pre-

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Undergraduate CEU participants at the DNP Meeting.

INTERNATIONAL NEWS

Latin American Societies Take Lead in Enhancing Physics Collaboration Internationally

An unprecedented number of representatives from 21 national and regional physical societies throughout the Western Hemisphere — including the APS — met in Cuernavaca, Mexico in early November for a conference on enhancing physics collaboration in the Americas. The meeting's primary purpose was to examine the status and potential for promoting scholarly exchange in the Americas, with particular emphasis on education and research collaborations.

"Historically, there has always been a special relationship between the U.S. and Latin American physics communities," said Irving Lerch, Director of International Affairs, pointing out that a decade ago, Fermilab's then-director Leon Lederman specifically promoted such programs. More recently, APS Executive Officer Judy Franz and outgoing President Andy Sessler have sought to further encourage Latin-American participation through an invigorated program of collaboration among the physical societies. "The growing presence of Latin-American physicists in North America has created new opportunities to promote increased participation in hemispheric research and academic programs."

The Cuernavaca conference was unique from past regional meetings not only in its format — a structured agenda with specific items for discussion — but also in the sheer range of the countries represented: Mexico, Brazil, Argentina, Cuba, Nicaragua, Ecuador, the Dominican Republic, Bolivia, Panama, Venezuela, Colombia, Peru, El Salvador, Guatemala, Uruguay, and Costa Rica, as well as Spain, the U.S. and Canada. "I don't think there's ever been a meeting of this magnitude before, with this level of participation," said Gordon Drake

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Inside...

Putting a Face on Physics

What good is physics, who are physicists and what on earth do they do? APS is keenly aware that most people can't answer those questions with any specificity, and that a deeper public appreciation of physics is important for the continuing health of the field and the nation. A fuzzy but increasingly positive image of science and physics appears to be forming in the minds of the American public, thanks to the recent vigorous efforts of many individuals and organizations. A new APS project, "Public Face for Physics" (PFP) aims to sharpen the focus.

In short, PFP seeks to identify a cadre of physicists who are so enthusiastic and articulate in explaining their research that their personalities and the clarity of their communication will "put a face" on physics when they appear in broadcast or print media. The idea arose as APS worked with the Edelman Worldwide public relations firm to publicize the 1999 Centennial, and to find ways to use the event to raise public awareness and appreciation for physics. PFP is now an independent experiment, lead by APS Executive Officer Judy Franz and 1990 APS President Eugen Merzbacher.

Franz and Merzbacher asked physics department chairs nationwide for recommendations of faculty members who were superb communicators. Nominations were also sought from the public relations network of DOE laboratories and from industrial members of APS Council and key committees. "The response was overwhelming," Merzbacher said. "A few people declined for personal or professional reasons, but most were eager." The resulting group of over twenty individuals represents the diversity of physicists and the work they do.

To begin the process, each member was asked to provide a concise bio and an essay on his or her work, written for a reader who has no physics background. Four experienced APS and AIP science writers then worked with the teams to refine the essays. At this point Edelman took over, bringing the team together in two subgroups to undergo media training. After a presentation on the principles of dealing with the

PFP participants at their recent media training session.

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CRITICAL CENTENNIAL MEETING DEADLINES

Early Registration	**1/15/99**	**Post Deadline Abstracts** (Posters only)	**2/19/99**
Late Mail/Fax Registrations	**2/20/99**		
Late On-Line Registrations	**3/08/99**	**Housing and Tours Deadline**	**2/20/99**

See Enclosed *APS Meeting Announcements* for complete Centennial Registraion Information

Friedman Outlines Priorities for Centennial Year and Beyond

Jerome Friedman, an Institute Professor of Physics at Massachusetts Institute of Technology, assumed the APS presidency on January 1st, 1999. In the following interview, he outlines his prevailing concerns and priorities for the Society in the coming Centennial year.

Q What primary goals do you hope to see the APS accomplish during its Centennial year?

A This is a celebration of 100 years of the APS, and 100 years of enormous advances in physics. But we also want to use this event as an opportunity for extensive outreach to the general public, to policy makers and to students. The APS must do more to ensure the health of physics at a time when science in general is facing serious challenges.

The message we want to communicate is that physics provides us with an understanding of how the world works and provides a context of how we see ourselves in relation to the universe. An equally important message is that the way we live is very much a product of the physics discoveries of the past and the technologies developed from them. But the Centennial is just the beginning. The physics community must keep addressing these issues, because the public's memory is quite short. We would like to find out what's successful in our Centennial outreach programs and build upon those successes.

Friedman Fact Sheet

- PhD in experimental particle physics from University of Chicago in 1956.
- Joined MIT faculty in 1960, where he has served as director of the Laboratory for Nuclear Science and as head of the physics department.
- Former vice chair of the Board of the University Research Association; also served on the National Research Council's Board of Physics and Astronomy, and on the APS Physics Planning Committee.
- Recipient of the APS W.H.K. Panofsky Prize in 1989.
- Shared 1990 Nobel Prize in Physics with Henry Kendall and Richard Taylor for demonstrating existence of the top quark.

Q Why is public outreach still so important, and what role can the APS play in encouraging public support for science?

A The nation has many diverse needs, and the scientific community must ensure that the public and the policy makers are aware of the importance of science. In doing this, it is very important that we represent the physics community in a unified fashion in order to be effective. Because of the diverse range of subfields represented within the Society, it is essential that the APS help unify the various disciplines to enable the physics community to speak with one voice. We have also joined with over 100 other scientific societies to become a unified advocate of better funding for science and technology in general.

In recent times the pursuit of science has been viewed by many as a luxury the nation can hardly afford in a period of budgetary and major social problems. There have been a growing number of people in government who have rejected the implicit assumption that the pursuit of scientific knowledge has social as well as intellectual value; and they have wanted guaranteed, short-term benefits as the justification for their support of science. Government leaders and the public must understand that science and applied science are investments that are critical for the future of the nation, and that the federal budget should provide adequate support for both basic and applied research. In the long run, science can prosper only if the public truly supports it.

Q How can the APS achieve this same sense of unity within its own membership ranks?

> "My personal vision is an APS that enhances the ability of physicists to do their work and contribute to society, and also plays a role in establishing educational levels of excellence."
>
> *Jerome Friedman*
> *Incoming APS President*

A In order to continue to make the Society more responsive to the needs of its members, we must make additional efforts to communicate with them to find out how to best serve their needs as well as those of the physics community at large. In identifying common needs and goals and by trying to fulfill them, the APS helps provide a sense of unity within its membership. We can certainly do better in making the APS a more inclusive society for both PhD and non-PhD physicists so that we have a Society which represents all physicists in the nation, with a total integration of the physics community. We also must better integrate the academic physics community with the industrial physics community. Enlisting greater participation of the industrial physics community is vital. National productivity depends on a broad scientific enterprise that is both capable of creating the foundations for new technologies and developing them.

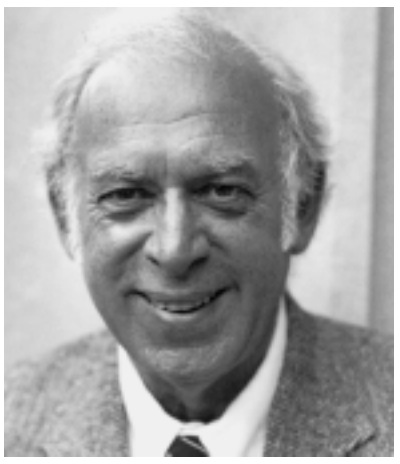
Q It is generally agreed that scientifically trained employees are critical for tomorrow's workforce, yet the U.S. educational system has failed to provide many young people with the scientific literacy required to succeed in a technological society. How is the APS addressing this issue?

A Although we have made great strides in educational outreach, we must continue to strengthen our educational program. In addition to a trained workforce, we need to have a scientifically literate public in our democracy, in which there are many political issues that have scientific and technological components. The APS can play a role in making sure that the public gets the educational background in science that they need in order to effectively participate in such decision-making. We should extend our existing efforts to inform the public about such issues and also increase our associations with science teachers to help them devise effective curricula to train a future scientifically literate public.

Q What do you see as essential to attracting more students to the field of physics, based upon your personal experience?

A I was an art student in high school and was planning on making art my career, having been awarded a scholarship to the Museum School of the Art Institute of Chicago. But during my senior year in high school, I picked up a book on relativity and was fascinated. I really couldn't understand it, but I realized that it was something I wanted to understand. I became very curious about the physical world as a result.

If we want to attract students into science, we have to relate it to the world in which they live and whet their sense of awe and curiosity. They have to be told not only what we know about science, but also what we don't know and what some of the outstanding questions are. People go into science because they are extremely interested in understanding nature. So if an educational system wants to attract students into science, it must give them a sense of the wonders of nature quite early.



Q National programs in educational outreach and curriculum reform abound, and yet science and math scores continue to plummet. Do you think local grassroots efforts would be more effective in achieving significant improvements?

A The national efforts establish a necessary framework. But it is true that we must interact locally with teachers and education administrations to really accomplish effective change. It's very difficult to effect changes from the top that penetrate down through the entire system. The local outreach efforts of APS Education Director Ramon Lopez have been extremely effective. We should continue in that direction and also encourage the participation of the APS membership. We should give them the support they need to get involved at the local level in interacting with teachers and also in such issues as developing state standards for science education. Many of these educational initiatives are state or local issues, but we can still provide a framework in which our members can participate in a meaningful way.

Q As physics continues to become an increasingly global enterprise, what role do you see the Society playing in the international arena?

A We have many members from outside the U.S., and most of the manuscript submissions to our journals are from foreign authors, so we are playing an important international role already. There are things we can do in the international arena but the APS should pick its goals carefully, focusing on issues in which we think we can be effective, such as human rights and open scientific communication. And we must continue to foster collaboration with physicists from other parts of the world, through IUPAP and interactions with other physical societies.

Q As we stand poised on the brink of a new millennium, what do you envision for physics in the future, and the Society's role therein?

A We have had 100 years of spectacular physics achievement, and we can envision comparable achievements for the future. There's no question that the intellectual questions to be answered are very deep and manifold. There will be major discoveries that we cannot anticipate as well as revolutionary new technologies, and much more multi disciplinary work. Physics in the 21st century will require an environment in which all of its various manifestations can flourish. The APS can continue to play an important role in fostering such an environment by informing members of government and the general public of the intellectual and practical benefits of science.

My personal vision is an APS that enhances the ability of physicists to do their work and contribute to society, and also that plays a role in establishing educational levels of excellence. I would like us to be seen as an organization that looks outward as well as inward.

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Physical Review Focus

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PR Focus is a FREE APS electronic journal featuring selections from *Physical Review Letters* explained at a level accessible to all physicists. The editor is David Ehrenstein [see page 1, April 1998 *APS News*]. *PR Focus* is available at the web address: **http://publish.aps.org/FOCUS/**. *APS News* is printing samplings from *PR Focus* to introduce the membership to this new journal. To receive one-paragraph introductions (such as the one below) each week by e-mail, send the following message to majordomo@aps.org: subscribe focus [Leave the subject line blank].

Antigravity in a Sandbox

Large objects seem to defy gravity in a shaking box of sand, according to a report in the 16 November *PRL*. The authors found that with vigorous shaking, heavy objects placed in the sand float to the top, while light objects sink. They propose a partial explanation for the phenomenon but admit to being puzzled by some of their observations. The experiments provide an example of the surprisingly complex behaviors physicists have seen in granular materials, which do not obey standard equations for either fluids or solids. (Phys. Rev. Lett. **81**, 4365; see the **complete** *PR Focus* story, including videos, posted online 23 November 1998.)

Troy Shinbrot/Rutgers University

Fancy flows. Shinbrot and Muzzio found these unusual flow patterns when they tilted the bed of sand.

More Things in Heaven and Earth: A Celebration of Physics at the Millennium

Benjamin Bederson, New York University (ed.)

A century of unparalleled scientific and technological change, mostly fueled by the discoveries of physicists, draws to a close simultaneously with the beginning of the second century of the APS and the onset of the third millennium. To acknowledge and celebrate these milestones, the Editor, with the assistance of the Editorial Board consisting of Kurt Gottfried, Walter Kohn, Eugen Merzbacher, Myriam Sarachik, Andrew Sessler, and George Field asked some preeminent physicists to create a contemporary portrait of their subfields, highlighting achievements, current vitality, and likely directions. The resulting 54 articles give us a unique opportunity to celebrate this century of physics. The volume is published to coincide with the APS Centennial meeting in Atlanta, simultaneously as both a supplement to the March 1999 *Reviews of Modern Physics* and as a hard-cover book from Springer-Verlag New York. Inc.

Among the authors are 15 Nobel Laureates and over 40 members of the National Academy of Sciences and of the National Academy of Engineering. The articles, often personal in tone, are written at the level of departmental colloquia. Some are intended to be broad but not encyclopedic, while others are presented as "case studies" focusing on particularly fascinating illustrations of specific topics. Major sections include: historical perspectives: particle physics; astrophysics; nuclear physics; atomic, molecular and optical physics; condensed-matter physics; statistical physics and fluids; plasma physics; chemical physics; and the applications of physics within other fields. Together, the articles combine to paint an illuminating and sweeping canvas of a remarkable time in science and civilization. See the APS and/or Springer websites (http://www.springer-ny.com) for more information.

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APS receives donation from EIS

The Educational Institute for Superconductivity (EIS) has made a generous donation of $26,000 to the APS to support the Society's public affairs programs and the Robert Wilson Prize fund. EIS is a non-profit corporation devoted to education in the general field of superconductivity.

A century of physics

1985-1995: Taking a Second Look

by Hans Christian von Baeyer, College of William and Mary

The news of the fall of the Berlin Wall (1989), the re-unification of Germany (1990), and the disintegration of the Soviet Union (1991), rang out over an astonished world like so many peals of a great bell celebrating the end of the Cold War. As global tensions diminished and global trade flourished, the world seemed determined to make a fresh start.

Photo from the A Century of Physics Time Line Wall Chart

Stephen Hawking

Physics, too, entered a new phase. The headlong rush into new discoveries that had started after World War II was slowing down, mainly because over the years science had grown cumbersome. Theories were becoming so complex that even supercomputers couldn't keep up with the calculational demands made upon them. Experiments in some branches of physics took years to plan and carry out, simply because they required enormous research teams, scientific instruments, and financial resources. Physicists took advantage of the more measured pace by going back to take a second, harder look at what had been discovered earlier in the century — sometimes with surprising results.

Since 1925 quantum mechanics had been an infallible guide to the atomic world, universally accepted, but difficult to interpret. "Nobody understands quantum mechanics," grumbled Richard Feynman. The advent of lasers, computers, and fast electronics led to the substitution of real experiments for mere thought experiments. Observations of the behavior of individual photons and atoms brought about increasingly convincing proofs that nature really is as bizarre as quantum mechanics makes it appear.

To describe nuclear and particle physics, a consistent theory based on quantum mechanics, relativity, and quarks had in two decades been refined to such a degree that it acquired the name Standard Model. Although it left many questions unanswered, it successfully accounted for all known particles and forces except gravity. The Standard Model confidently predicted the existence of a sixth and last quark named "top." But when the top quark was finally found in 1995, its huge mass turned out to be so grotesquely out proportion with the others that it became a new enigma itself.

On the human scale, the phenomenon of superconductivity, which had been discovered in 1911 and explained in 1957, also produced a bombshell: the detection of superconductivity at much higher temperatures than had been thought possible. What's more, the old explanation did not fit the new observations, so theorists had to start all over again.

On the cosmic scale, new instruments mapped out the microwave background radiation (discovered in 1965) at an unprecedented level of detail. The new data encouraged cosmologists, including the British physicist Stephen Hawking, to tackle a theory of "quantum cosmology," which deals with the wave function of the entire universe, and the beginning of time. It will be the ultimate union of atomic and cosmic physics.

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

In the February 1999 issue, APS News will feature the last introductory essay:
1995 - Prospect

CENTENNIAL PHYSICS FESTIVAL — Mastering the Mysteries of the Universe

In celebration of physics of the 20th and 21st centuries, APS will host an ongoing outreach physics festival from March 15-27, 1999 in cooperation with cultural and educational institutions of Atlanta. In addition to events scheduled at the Georgia World Congress Center, festival events will also take place throughout the metropolitan Atlanta area including Olympic Park, school sites, theaters, museums and other public spaces. The Festival will have five main components:

1. POPULAR TOPICS PHYSICS LECTURES (Popular physics talks at the Georgia World Congress Center, plus locations indicated below, for arranged groups of students, teachers and meeting attendees.)
- **Physics of Dance** ..... Ken Laws, *Dickinson College* (Atlanta Ballet)
- **Physics of Rainbow** ..... Robert Greenler, *University of Wisconsin, Milwaukee*
- **Physics of Brass Instruments** ..... Brian Holmes, *San Jose St. Univ.* (Georgia St. Univ.)
- **Physics of Fractals and Art** ..... Richard Voss, *Florida Inst. of Tech.* (Atlanta College of Art)
- **Physics of Sports** ..... Richard Brandt, *New York University* (SciTrek Museum)
- **Physics of Star Trek** ..... Lawrence Krauss, *Case Western Reserve* (Downtown Theaters)
- **Physics of Beer** ..... Sid Perkowitz, *Emory University* (Local Brewery)

2. ON-CAMPUS CELEBRATION EVENTS
- Science Communication Conference (Emory University)
- Fractals and Chaos Symposium (Georgia Inst. Tech.)
- Physics and Industries of the Mind Symposium (Georgia State)
- History of Black Scientists (Clark-Atlanta)
- Others (TBD)

3. PHYSICS AND CULTURAL EVENTS IN THE ARTS, DANCE & THEATER
- Felice Frankel Photography Exhibit on Physics & Art (Fernbank Museum)
- Microscape Photography Exhibit by Lucent Technologies (TBD)
- New Plays on Physics Topics (TBD)

4. PHYSICS DEMONSTRATIONS (in Olympic Park, Atlanta Public Schools, SciTrek Museum)
- Group from Florida State National High Magnetic Field Laboratory
- Group from Hampton University
- Third group to be determined

5. RENOWNED PUBLIC SPEAKERS
- Stephen Hawking (*pending confirmation*), University of Cambridge (Atlanta Civic Center)
- More

OPINION

On *Unlocking our Future*

by George Brown, D- CA, Minority Leader, US House Science Committee

The National Science Policy report *Unlocking our Future: Toward a New National Science Policy* [see www.house.gov/science/science_policy_report.htm and *APS News* Back Page November 1998,] attempts to provide some guidance to Congress on science policy for the coming years. I appreciate the hard work done by the report's author, Congressman Ehlers, but I cannot endorse the report as written because it fails to take on some of the issues I think are most important to the future health of the scientific enterprise. However, I fully expect this report to stimulate a lot of discussion and thinking.

Any discussion surrounding this report or this broad topic must be put in context and not viewed as an isolated event. Just as the growth of science has accrued over centuries through the contributions of many individuals, working in different disciplines and cultures, so has science policy expanded and developed as it seeks to define and implement the role of science in achieving broader societal goals. This process has never been smooth and continuous, although the outcome seems to create inexorable change.

Vannevar Bush, although a towering figure in science policy in the United States, was not the first, nor will he be the last, to offer a framework conceptualizing the role of science in the world.

President Gerald Ford helped redefine the Federal role in science policy with the signing of the Science Policy Act of 1976, a major work of the House Science and Technology Committee. While never fully implemented, this Act led to the further definition of the Federal role in technology transfer and advanced technology development in the 1988 Trade Bill signed by President Reagan. This Act opened up a restructuring of the broad area of government-industry-university cooperation as one way of making the U.S. national industrial system more competitive with the national systems of Europe and Asia, which historically had encouraged closer ties between government and industry.

During the Bush Administration, under the skilled guidance of his Science Advisor, Dr. D. Allan Bromley, and with the input of many science and technology organizations, continued progress was made in improving the process of innovation, of moving new inventions and technologies from the labs to the marketplace, and defining, through the device of cooperative research and development agreements, the legal structure for individual institutional agreements.

With the end of the Cold War, this policy debate has intensified. The House Committee on Science, Space, and Technology issued a report in 1992 on the health of research. The Clinton Administration has attempted to make its imprint on science policy with the 1994 report, Science in the National Interest, a product of the Office of Science and Technology Policy. This report prompted Congressional hearings and a renewed discussion of science and technology policy at the national level. All of this background is offered to provide an historical perspective on our current discussions. By way of providing some context, I would offer some guiding principles that I think will be useful as we enter into an ongoing dialogue about the future of science policy.

1. A new science policy should reflect our understanding of the process of creativity and innovation. Virtually no one still believes in the Bush-era linear model of scientific breakthroughs leading inexorably to technological developments. Despite report language endorsing a more sophisticated model of science and technology innovations arising through an iterative process, the Ehlers report ultimately puts its money on the old linear model by emphasizing Federal support for "basic" research. The report provides no guidance on how the Federal government should determine that a "market failure" has occurred in the downstream parts of the R&D process or what types of policies would be appropriate to redress such failures. I think we should work together to develop a policy on the appropriate limits of Federal support that fits with our understanding of how innovation actually works. Let's put our money where our model is.

Further, the Ehlers report seems to support the traditional "hard" sciences with only passing mentions of engineering or the social sciences. I think we need a more holistic conception of what constitutes important science and worthwhile endeavors. An argument can be made that the most pressing issues facing our society - crime, education reform, social justice - are more likely to be addressed through investments in social science rather than in the hard sciences. Yet, the report is silent on the need to support this important research.

2. A new science policy should articulate the public's interest in supporting science - the goals and values the public should expect of the scientific enterprise. Over fifty years ago, Vannevar Bush argued that science was worth public support because it could "insure our health, prosperity, and security as a nation in the modern world." I think those general goals are still valid today. However, I also believe that we need to do a more rational job of identifying specific social needs that science can help us remedy. What are the long-term goals for society which the public should expect from these investments? To put it simply, science for what end? It isn't enough to declare science a public good and walk away from the table. When we use public resources to support science and technology, we should clearly identify the public purposes which we desire to achieve.

In addition to clearly articulating the goals for science, we need to squarely face the values that science can help enhance or undermine. I am particularly concerned about the possibility that increasing technological sophistication and mal-distribution of educational opportunity could create a two-tier society. What steps can we take to guarantee that we do not become a society of technological haves and have nots? This is a question of justice and equity in access to science education, and to the fruits of the scientific and technological enterprise.

To give just one example, it is unfair to use public funds for biomedical research if the fruits of that research are so expensive that only a handful of the most economically advantaged can enjoy them. That is a hidden redistribution of wealth and life-expectancy from poorer Americans to richer Americans under the guise of "basic" research in the life sciences. A new science policy must wrestle with these types of questions.

3. A new science policy should point towards decision-making tools for better investment choices. Having identified clear goals and values, a new science policy should point towards methods we can use for making better decisions. We need a yardstick by which to measure progress. Some of the elements for that are in place. For example, the Government Performance and Results Act (GPRA) challenges our agencies to develop comprehensive goals and measurements. However, in research and development programs, GPRA is still a fairly blunt instrument and is in need of fine-tuning.

The Office of Science and Technology Policy is in a position to provide some overall coordination for our science policy, but it doesn't always have the muscle to make its desires stick with executive agencies. Finally, Congress has wonderful leadership in both parties on science policy questions, but we suffer from a disorganized process for passing authorizations and appropriations that leads to sub-optimal outcomes. I think that we need to tackle all of these elements of decision-making as we move towards a more rational analysis of the major problems facing society - affordable health, broadly based economic opportunity, sustainable environmental policies and social discontent - and of the science needed to address those problems.

I hope that as we begin a dialogue on the Ehlers report, we can use these principles to inform the debate. I look forward to working with my friends inside and outside of Congress.

APS VIEWS

How to Become an APS Fellow

by Barrett Ripin, APS Associate Executive Officer and Ken Cole, APS Honors Program

It is time for the annual call for APS Fellowship nominations. Fellowship is one of the highest levels of professional recognition conferred by the APS and by one's peers. It recognizes members who have contributed to the advancement of physics by independent, original research or who have rendered some other special service to the cause of the sciences.

The nomination process is straightforward and not terribly time consuming. A nomination form that cites the principal contributions of the candidate to physics is filled out and signed by two members of the Society (they do *not* have to be Fellows themselves) and sent to the Executive Officer prior to the operative deadline. Typically, one or two additional letters of support are included in the package, as well as a CV or publication list for the nominee. A nomination remains active for up to two years.

Contributions may consist of advances in knowledge through original research and publication, significant and innovative contributions in the applications of physics to science and technology, or significant contributions to the teaching of physics or service and participation in the activities of the Society.

After receipt by the APS, most nominations are first sent to the fellowship committee of an appropriate division, topical group, or forum for peer review. Neither the nominee nor nominators need be members of that unit. Unit fellowship committees forward their recommendations to the APS Fellowship Committee, chaired by the vice-president of the Society, which reviews the qualifications of all candidates including a few that do not fit within any unit's purview. From there, nominees are presented to Council at the Elections Meeting. There is an APS Constitutional limit to the number of fellows elected annually of no more than ½ of one-percent of the membership, or about 200 per year.


Ken Cole

The above process is not as formidable as it may seem. If you know of a deserving colleague, nominate him or her. They will remember this gesture for the remainder of their careers – I do. Don't be shy, if you think you qualify, drop big hints to colleagues who might nominate you. Unfortunately, many outstanding candidates are overlooked simply because colleagues *assume* that they already are fellows; this happens even to Nobel Laureates! Foreign, women, minority, and industrial physicists appear relatively underrepresented among fellows. If you belong to an underrepresented group and know of someone who deserves to be nominated, make a special effort to nominate them – if not you, who?

Instructions for submitting fellowship applications and deadlines are on page 7 and under the Fellowship button of the APS Home Page [www.aps.org], or call the honors office at (301) 209-3268.

LETTERS

APS News Insults Two Texas Cities, Simultaneously

How could you?! The ISEF met in Fort Worth, as the article (October 1998 *APS News*) states. How did Dallas get into the headline? Shame on you and the other editors. We in Fort Worth are very sensitive about this. But, maybe it all goes back to the Washington meeting being held in Baltimore, or the New York meeting (who remembers that) being held whereever, or something like that.

Carroll Quarles, *Texas Christian University*

"Feynman Fish" Offends Members

Editor's note: Several members were offended by the designation "Feynman Fish" on one of the bumper sticker entries in the October 1998 'Zero Gravity.' They felt that it mocked the Christian symbol of the fish, whose spelling in Greek "Ichtus" is an acronym for "Iesous Christos Theou Huios Soter," or "Jesus Christ, Son of God, Savior." *APS News* apologies for this inadvertant offense. A better description of the graphic might be "Feynman Diagram."

INSIDE THE BELTWAY

A Washington Analysis

Gridlock or Governance, What'll It Be?

by Michael S. Lubell, APS Director of Public Affairs

Predicting the fortunes of science in the aftermath of the 1998 elections is harder than picking a winning number at the roulette table. The political gurus proclaimed the outcome an upset of historical proportions, and the party faithful accepted the dictum as gospel. New leaders and uncertain agendas are the result. Here's how it came to pass.

Politics is like the stock market: It's expectations that count. Hewlett-Packard might announce a $50 million quarterly loss, and its stock could still rise ten percent — if analysts were expecting a $100 million loss.

That's pretty much what happened to the Democrats last November. Political observers were anticipating that Republicans would pick up fifteen to thirty seats in the House of Representatives and three to five seats in the Senate. So even though the GOP outscored the Democrats 223 to 211 in House races, maintained their 55 to 45 majority in the Senate, finished with a 31 to 17 advantage in state governors and won 51 to 49 percent in generic voting, pundits declared the Democrats electoral victors.

As a result, President Clinton, who had heard daily calls for his resignation prior to the election, still sat in the Oval Office after the November voting, looking stronger than ever. Instead of the President, it was Speaker Newt Gingrich who left Washington, after his GOP colleagues unceremoniously booted him out of the House leadership position in the election aftermath. With his political passing, Washington lost one of its most outspoken and controversial techno-futurists.

Licking their wounds of failed expectations, the Republicans acted quickly to elect new leaders, or at least replace the ones who had previously pledged their allegiance to the deposed Speaker. In its first organizational meeting last November 19, the GOP elected former Appropriations Committee Chairman Bob Livingston of Louisiana to the top House position, installed ex-Oklahoma football star and family-values advocate J.C. Watts as Conference chairman and selected Tom Davis of Virginia as head of the National Republican Congressional Committee.

The only survivors of the party purge were two Texans, Majority Leader Dick Armey and Majority Whip Tom DeLay, staunch conservatives who had been openly critical of Newt Gingrich's pragmatic bent well before the November election. Still, Armey had to fend off challenges by Washington's Jennifer Dunn, a social moderate, and Steve Largent, another Oklahoman with football and family-values credentials. Only Tom Delay escaped unscathed.

Although some of the faces are different, the complexion of the new House GOP leadership is still very conservative, socially and fiscally. Their style may set them apart from their predecessors, but their political philosophy certainly won't. Where they will come down on science is anybody's guess.

Democrats also made some leadership changes, but only because of vacancies created by retirements. Minority Leader Dick Gephardt of Missouri and Minority Whip David Bonior of Michigan retained the party's two top posts, unchallenged. Democrats also elected Texan Martin Frost as chairman of their Caucus and selected Robert Menendez of New Jersey as vice-chairman. Patrick Kennedy of Rhode Island moved into Frost's former position as chairman of the Democratic Congressional Campaign Committee.

The Senate, despite some grumbling in the GOP ranks, decided not to shuffle the leadership deck at the top. Majority Leader Trent Lott of Mississippi and Minority Leader Tom Daschle of South Dakota will both be back to direct the Senate's collegial jousting.

Leaders in both parties ordinarily agree on very little, but they are of one mind when it comes to why the Democrats exceeded expectations. While the GOP was blasting President Clinton for lying about his sexual escapades, the Democrats controlled the debate on education, Social Security and HMO reform. These were the core issues voters said they truly cared about. Add Republican capitulation on tax cuts and budget caps during the final days of the congressional session, and you have the makings of a disenchanted GOP electorate sufficient to swing a number of contested elections over to the Democrats.

What went almost unnoticed by many analysts was the pivotal role organized labor played in many key districts. Union households accounted for about 23 percent of the votes cast this year, up almost six percent from the last election. And they voted Democratic by a margin of two to one.

The African-American community, always a Democratic bastion, also turned out in greater numbers in districts where it counted. This year, they voted Democratic by a margin of more than eight to one.

About the only place where the GOP met or exceeded pre-election expectations was in the gubernatorial arena. There, moderate Republican candidates won overwhelmingly, even in Democratic strongholds: Cellucci in Massachusetts, Almond in Rhode Island, Rowland in Connecticut, Pataki in New York, Ridge in Pennsylvania, Engler in Michigan, Thompson in Wisconsin, Taft in Ohio, Johnson in New Mexico and the Bush brothers in Texas and Florida.

The counterpoint: Ideologically conservative Republicans—or at least those perceived as such—lost in Senate races in New York, South Carolina, North Carolina and California and in governor's races in California and Alabama.

In all of these states, voters delivered a strong, unambiguous centrist message. The question is whether leaders in either party heard it and if they did, whether they will be able to maintain control over their fractious members.

As it was in the 105th Congress, the House of Representatives will be the place to look for the answer. Here are the two scenarios most widely accepted inside the Beltway.

With one independent usually supporting the Democrats, Republicans now hold a razor-thin margin of eleven votes in the House. A mere six defections will cause the GOP to lose a vote. Therefore, according to the governing-from-the-middle scenario, the fifty or so moderate Republicans will reach out to the fifty or so moderate Democrats and establish a coalition that will control the outcome of any contested vote and, thereby, the agenda of the 106th Congress.

That's the view of the optimists. The pessimists point out that the GOP is still dominated by the ideological right and that labor and the left will tell the Democratic leadership that it's pay-back time for delivering the goods in the 1998 elections. According to the gridlock scenario, the House will become even more polarized and suffer terminal paralysis.

Which scenario proves correct will determine how well consensus issues fare. The fate of science, arguably the quintessence of such issues, largely hangs on the outcome. If gridlock prevails, science could be gasping for air by the time Congress sends its budget bills down Pennsylvania Avenue next fall.

Inside the Beltway, *continued*

zero gravity

Have You Got the Libido for Politics?

by Francis Slakey, APS Associate Director of Public Affairs

I don't read Cosmopolitan. I swear it. O.K., so maybe I flipped through a copy at my dentist's office. But what choice did I have, for God's sake? I'm not going to read the pamphlet on gum disease! And yes, I admit it, while I was flipping through the magazine, I took the libido quiz to see whether I'm "limp lettuce" or a "raging coal." Scientists are curious, after all. We don't judge something without giving it a try.

The problem is, the results can be embarrassing. I'm not saying they were for me. Heck, I'm not going to be lectured to by a silly little magazine with scratch and sniff ads. I'm just saying that there are some people who might not be able to handle the results. You run a risk, is all.

So, here's what you can do instead. Next time you're going to your dentist's office, bring this article along with you. It's a quiz to see whether you've got the libido for politics. There's no risk at all, because no scientists in their right mind want to go into politics anyway. Here goes:

1 Do you believe that research on the optical properties of quantum dots is likely to build a better world? Do you believe the public sleeps more soundly at night knowing that Fermat's Last Theorem has finally been proven? Do you believe that increasing the minimum wage has little effect on peoples lives? (1 point for each no answer.)

2 When Congress regulates the logging industry, should they also limit the amount of paper available for scientific publications? (Add 1 point for yes.)

3 Calculate the total amount of federal funding (FF) that goes into your research project. That includes the federally funded equipment in your laboratory, your federally funded research salary, and the three minutes a week that your federally funded advisor spends dissing your work. Now, estimate the economic returns (ER) of your research. If FF < ER, then you have nothing in common with the self-indulgent career of a political opportunist. (If FF > ER add 1 point.)

4 Do you think there should be term limits for professors? (Add 1 point for yes.)

5 Have you ever wanted to be a member of the National Academy of Science? A fellow of the AAAS? An invited speaker at a scientific meeting? An author of a paper that appears in Physical Review Letters? The first author of any scientific paper that appears in any magazine in any country? If not, then you have nothing in common with a status hungry politician. (1 point for each yes answer.)

If your total score is less than three, go hibernate with your slide rule — the lab is your home. If your total score is more than nine, hire a campaign manager.

But, if you're somewhere in between, then you should consider science policy as a career. And at the moment, you have a terrific opportunity to explore politics. I guarantee you, there's a federal election campaign raging within ten miles of your pocket protector. Choose your candidate and volunteer a few hours a week of your time. If you like it, you'll have gotten the experience you need to compete for a policy job in Washington. If you hate it, move to Canada.

Of course, that's not the only way to explore politics. A year ago I would have suggested internships. But nowadays, a Washington intern may wind up in Vanity Fair. But at least it's not Cosmo.

Centennial Session to Highlight McDermott's Contributions to Physics Education Research

The American Association of Physics Teachers (AAPT) will hold a special session at the APS Centennial meeting in Atlanta to honor Lillian Christie McDermott for her outstanding ongoing contributions to physics education research. The session will be chaired by Leonard Jossem of The Ohio State University and will consist of a series of invited research talks by physicists whose work has been significantly influenced by McDermott.

For more than 20 years, McDermott has been a leader in establishing research as a basis for the systematic improvement of the learning and teaching of physics, and her work, which is continuing, has influenced the development of nationally recognized curricula. She is a Professor of Physics at the University of Washington and director of the Physics Education Group in which students earn a PhD in physics for research in learning and teaching of physics. The program was the first of its kind and has served as a model for others throughout the United States. More than 500 faculty have also benefited from the faculty development workshops given by the group at APS, AAPT and other national meetings and at colleges and universities around the world.

McDermott earned her PhD in experimental nuclear physics from Columbia University in 1959. She served as the first chair of the AAPT Committee on Research in Physics Education, has served on the APS Executive Board and as chair of the APS Committee on Education. She is also a past recipient of the AAPT Millikan Award for "notable and creative contributions to the teaching of physics."

International Desk,

continued from page 1

(University of Windsor), who represented the Canadian Association of Physicists (CAP). "I gained a much better knowledge of the needs of Latin American countries and made many new personal contacts."

According to APS delegate James Vary, director of the University of Iowa's International Institute of Theoretical Physics, there was a general recognition among the participants not only of the increased internationalization of physics, but also of the fact that the physics community has common problems to address that transcend national borders: improving the quality of physics education, improving the public perception of physics, and advancing scientific research through better collaborative programs, to name a few. The emphasis on bilateral exchange, without a sense of U.S. patronization, was also an important feature of the meeting. "The focus was on finding those areas where both sides benefit by working together because in the end those are the ones that will be sustainable efforts," said Vary.

Bill Blanpied (National Science Foundation), who has long been active in APS international concerns, was particularly encouraged by what he perceived as a new sense of leadership on the part of the Mexican Physical Society (SMF, Sociedad Mexicana de Fisica), which chiefly organized the meeting. "I think in recent years the SMF has gained a great deal of confidence in its own ability to step forward and take initiative," he said. "If there's going to be any significant networking of physical societies in the Americas, the U.S. can't take the lead. We can be supportive, but it's got to be the Latin American countries that take the early steps forward."

"For me, the meeting served to put into perspective not only the areas in which we have a lot of common ground, but also to highlight areas in which we are not always in universal agreement," said Lynn Boatner (Oak Ridge National Laboratory), another APS delegate who chairs the APS Committee on International Scientific Affairs. Lerch said, "If you're going to make progress, you need to work around these, either by resolving them, if you can, or by avoiding them to concentrate on the commonalities on which we can build a mutual understanding."

Following a day of presentations by representatives from various countries, participants split into three working groups. The three working groups were: 1. research exchanges; 2. educational exchanges; and 3. telecommunications, with each producing a series of recommendations for that area. In keeping with the general thrust of the meeting, the group on research exchanges ranked increasing the degree of cooperation between Latin American and U.S. and Canadian scientists as a top priority, although there has been some scientific collaboration in the past.

Attendees at the internatiional conference on enhancing physics collaboration in the Americas.

Better resource information was deemed crucial to fostering future collaboration. To this end, a directory of U.S. and Canadian researchers, as well as Latin American expatriates, willing to establish collaborations in Latin America is under development, along with a list of potential funding sources. Vary believes the APS and CAP can play a vital role in serving as a focal point for systematically organizing such information. Numerous members of the APS Forum on International Physics have already volunteered to be listed as scientific contacts. Sessler emphasized the need for Latin American physicists to become involved in the science policy and funding decisions of their respective countries. "If we put physicists in the government, it will be easier to educate the government about physics," he said, possibly resulting in increased funding for research and collaborations.

Improving the quality of high school physics education is another major goal. "There are quite low levels of support for physics and post-secondary education and research in Latin American countries," said Drake, who sees a strong need for more contact with the international physics community to broaden student horizons. "Many students coming out of high school haven't received anything near the same standard of training in physics that they would receive in the U.S. or Canada."

Suggestions for accomplishing this included establishing or improving training schools for teachers, translating AAPT materials into other languages, and enhancing the role of Physics Olympiads in all countries. To improve undergraduate, graduate and postdoctoral programs, the group suggested arranging exchange programs between universities for both students and professors, as well as summer internships at national laboratories in the Western Hemisphere so that students can gain valuable research experience. Establishing programs for promoting science among children in the general public could be accomplished with mobile museums, children's workshops, and visits to laboratories.

The working group on telecommunications recommended the immediate organization of a Western Hemisphere Council of Editors to study and propose ways of strengthening the electronic publishing enterprise in physics, and to coordinate the development and implementation of joint activities. The group also encouraged the physical societies of Latin America to form a confederation of journal users — i.e., institutional and laboratory libraries — to help define the journal access needs of the physics community, and negotiate agreements with journal publishers to gain the widest possible access to the physics literature.

The infrequency of citation among Latin American journals, compared with the major English-language journals, was of particular concern to many participants, generating a useful discussion on achieving a balance between regional diversity and international connectivity, according to Blanpied. "Physics is certainly international, but there is still something unique about the regional cultures and educational systems," he said. "How do you preserve the scientific culture of a region, which is represented to a large extent by the journals, and yet also somehow connect that to the international journals?" While no easy solutions emerged, participants discussed the possibility of translating the best papers published in Spanish-language journals to give them broader exposure outside the region.

Recognizing the commercial nature of the Internet, which is dominated by private enterprise and overseen by government, the telecommunications group urged FeLaSoFi; Federacion Latinoamericana de Sociedades de Fisica (Federation of Latin American Physical Societies), to form a working group to seek commercial, private foundation and government partners to achieve affordable and reliable access to the telecommunications networks. Boatner in particular believes that establishing an electronic communications network will be crucial to improving access and exchange of information between physicists in the U.S., Canada and Latin America.

The Importance of Physics in Modern Society

At the Cuernavaca meeting, a brief general statement was drafted on the importance and relevance of physics to all advanced societies. The intent was to construct a statement that would be broadly useful to the participants, at least as a starting point, in their lobbying efforts with their local governments for the support of physics. Individual points could then be amplified or elaborated upon as appropriate in particular cases.

It was suggested that this statement should also be forwarded to IUPAP for consideration and discussion at the IUPAP General Assembly meeting next March in Atlanta. The resulting document would perhaps then be useful in a broader context as a means to encourage better levels of support for physics in countries throughout the world. The text of the statement is available from the online version of the January 1999 *APS News* [www.aps.org].

Putting a Face on Physics,

continued from page 1

media, the group members participated in several practice interviews under the watchful eye of a video recorder. "My previous interviews were limited in scope to my immediate work, but this training prepared us for a much wider range of questions," said team member Richard Superfine. "The taped interviews were painful but there is no substitute for practicing some of the techniques that they described. Most interesting was the idea that we have control over any interview, and that we should make sure that we politely steer the discussion so that our own points get across."

The Edelman staff was equally enthusiastic about the PFP training sessions. "We've never worked with such quick studies," said Edelman senior account supervisor Tish Van Dyke. "They caught on fast and were so passionate about what they do. That's infectuous. If anyone can communicate physics, these people can." Edelman's next step is to prepare press kits and 'pitch' the PFP team stories. The targetted media channels are PFP participants' local newspapers and radio stations, and national outlets like CNN, NPR and airline magazines.

"The proof of the pudding will be the success in reaching the media," Merzbacher observed. A newly formed Task Force on Informing the Public about Physics will evaluate PFP in spring of 1999, and make a recommendation on whether it should be continued. The Task Force will evaluate present efforts and explore and recommend new ways for APS to inform the public, political leaders and other relevant constituencies about the nature and importance of physics to society.

One established way to introduce physics to the public is to start with what is close and familiar, like baseball, cooking, or weather phenomena and explain the physics involved. PFP will try the reverse: team members will explain their own sophisticated research in simple terms, using analogies to everyday items, and avoiding off-putting technical terms. "This is real physics," Merzbacher said, "presented to the public in ways they can understand."

APS Honors Undergraduates With 1999 Apker Awards

Brian Richard D'Urso of the California Institute of Technology and Gwendolyn Rae Bell of Harvey Mudd College have been named by the APS as recipients of the 21st Apker Award competition for their research achievements as undergraduates.

The Apker Awards were established by Jean Dickey Apker as a memorial to her husband, LeRoy Apker. Both were physicists employed the General Electric Research Laboratories in Schenectady, NY. Each year the selection committee invites five or six finalists out of the nominees to give presentations of their undergraduate research work. Apker Award recipients are selected from the finalists, usually, one doing their undergraduate work at a PhD-granting institution and one from a non-PhD-granting college. Finalists receive a $1000 award, a certificate, and expenses to the APS Centennial meeting. Their undergraduate institutions receive $500 each. Apker Award recipients each receive an additional $5000 and an invited paper at the Centennial meeting. Their institutions also receive a $5000 grant to further encourage undergraduate research.

Bell began her research concerning dwarf spheroidal galaxies at the U.S. Naval Observatory Flagstaff Station, while participating in a summer program sponsored by Northern Arizona University. Upon returning to Harvey Mudd College, she decided to continue the work as her senior research project. The resulting thesis provides an estimate of the total mass of the Milky Way within 100 kpc of galactic center by calculating the orbits of some of the Milky Way's satellite galaxies, called dwarf spheroidal galaxies. Bell's mass estimate is one of the few mass calculations that extends to such a large galactic radius and it relies on fewer assumptions than previous studies. Bell also examines the origins of the dwarf spheroidal galaxies themselves. Bell is now

Continued on page 7

Announcements

1999 APS Fellowship Nomination Deadlines

Fellowship nominations may be submitted at any time, but must be received by the deadlines listed below for 1999 review. Nomination forms and submission information may be found through the APS Home Page [www.aps.org] under the Fellowship button.

All nominations should be sent to: Executive Officer, The American Physical Society; One Physics Ellipse, College Park. MD 20750; ATTN: Fellowship Program

UNIT	DEADLINE (1999)
DIVISIONS	
Astrophysics	05/01
Biological Physics	06/01
Chemical Physics	02/15
Computational Physics	02/15
Atomic, Molecular, Optical	02/15
Condensed Matter	01/30
Fluid Dynamics	02/15
High Polymer Physics	01/15
Laser Science	04/01
Materials Physics	02/15
Nuclear Physics	04/01
Particles & Fields	04/01
Physics of Beams	03/15
Plasma Physics	04/01

UNIT	DEADLINE (1999)
FORUMS	
Physics & Society	04/01
History of Physics	04/01
International Physics	04/01
Industrial & Applied Physics	03/01
Education	Past
TOPICAL GROUPS	
Few Body	04/01
Fundamental Constants	04/01
Precision Instrs. & Meas.	04/01
Shock Compression	04/01
Gravitation	04/01
Magnetism & Its Appli.	05/06
APS GENERAL NOMINATIONS	**06/01**

January 15 Deadlines

See the December issue of *APS News* or APS home page (www.aps.org) for details about the fellowship program and application procedures.

1999-2000 APS/AIP Congressional Science Fellowships

The American Physical Society and The American Institute of Physics are currently accepting applications for their 1999-2000 Congressional Science Fellowship Programs. Fellows serve one year on the staff of a senator, representative, or congressional committee.

APS Mass Media Fellowship Program — Summer 1999

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. Visit http://aps.org/public_affairs/Media.html (includes PDF application forms)

FOR INFORMATION AND/OR APPLICATIONS:

APS Fellowship Programs
529 14th Street, NW, Suite 1050 • Washington DC 20045
(202) 662-8700 • email: opa@aps.org

CAUGHT IN THE WEB

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

Centennial
- Centennial Meeting Announcement
- GMAG Focused Sessions
- Student Travel Grant information

Units
- DCOMP and FIAP Fall 1998 Newsletters
- Mid-Atlantic Seniors Newsletter & Contact List

Committees
- POPA Annual Report and Patriot Performance Report

General
- List of Newly Elected APS Fellows
- Job Openings

centennial webpage:
www.aps.org/centennial

Call for Council and Committee Position Nominations

For:

VICE-PRESIDENT
GENERAL COUNCILLOR
NOMINATING COMMITTEE
Chairperson-Elect • Members
PANEL ON PUBLIC AFFAIRS
Chairperson-Elect • Members

Please send your nominations to: The American Physical Society; One Physics Ellipse; College Park, MD 20740-3844; Attn: Amy Halsted; (301) 209-3266; fax: (301) 209-0865; email: halsted@aps.org. A nomination form is available at www.aps.org/exec/nomform.html. **DEADLINE IS JANUARY 31, 1999.**

Now Appearing in RMP...

Reviews of Modern Physics **is a quarterly journal featuring review articles and colloquia on a wide range of topics in physics. Titles and brief descriptions of the articles in the January 1999 issue are provided below. If you would like to subscribe to the paper or online version of RMP, please contact the APS Membership Department at membership@aps.org or (301) 209-3280. George Bertsch, Editor.**

Quasinormal-mode expansion for waves in open systems (colloquium) — *E. S. C. Ching et al.* describe the quasinormal-mode approach to open systems.

Experiments and theory in cold and ultracold collisions — *John Weiner* and collaborators present the techniques for producing ultracold atoms and the phenomena associated with their interactions.

Trapped nonneutral plasmas, liquids, and crystals (the thermal equilibrium states) — *D. Dubin and T. O'Neil* review the properties of charged particles confined in Penning traps.

Photodissociation regions in the interstellar medium of galaxies — *Hollenbach and Tielens* review the present understanding of processes that go on in galactic gas clouds and the spectroscopic signatures.

The adiabatic molecule-metal surface interaction: theoretical approaches — *G. Brivio and M. Trioni* review the theoretical methods that have been applied to absorption of molecules on surfaces.

Multiresolution analysis of electronic structure: semicardinal and wavelet bases — *T. Arias* provides an introduction to wavelet theory.

Multiple scattering of classical waves: microscopy, mesoscopy, and diffusion — *M. C. W. van Rossum and T. M. Niewenhuizen* present the theory of wave transport in strongly scattering media.

Forty years of antiprotons — *J. Eades and F. J. Hartmann* review experiments on antiprotons which provide symmetry tests of unparalleled sensitivity.

Gravitational microlensing: a report of the MACHO project (colloquium) — *Will Sutherland* describes observations of star twinkling due to gravitational lensing.

Built upon sand: theoretical ideas inspired by granular flows (colloquium) — *Leo Kadanoff* discusses the motion of granular materials and raises issues to be resolved in order to build a better theory.

Parity violation in the compound nucleus (colloquium) — *Gary Mitchell* and collaborators describe the recent experiments showing parity violation in highly excited nuclear states.

Coming in March — Subscribers to *RMP* will receive *More Things in Heaven and Earth: A Celebration of Physics at the Millennium* a Centennial supplement (see description on page 3) in addition to the four regular issues of the journal at no additional cost.

Apker Awards, *continued from page 6*

beginning graduate studies in astronomy at the California Institute of Technology.

D'Urso began his undergraduate research at CalTech with numerical modeling of electromagnetic waves in photonic crystal structures. These calculations were used to design optical resonance cavities which utilized two dimensional photonic bandgap crystal mirrors. In his senior year, he used nanofabrication techniques to implement these structures in the InGaAs/InGaAsP material system. When optically pumped, the hexagonal cavities, which are less than 20 microns across, show strong resonance features. The ultimate goal of this project is to use the geometrical flexibility of the photonic crystal mirrors to create coupling paths between the cavities on a wavelength scale.

Following his graduation D'Urso has now begun graduate studies in experimental atomic physics at Harvard University.

Apker Award finalists (f) and judges (sc). [Rear, from left: Michael Brown (sc), Ali Kinkhabwala (f), Carl Steinke (f), and Laurence Marschall (sc). Front, from left: Harry Lustig (sc), Gwendolyn Bell (recipient), Brian D'Urso (recipient), Sylvia Smullin (f), and Barrie Ripin (sc). Selection committee members not in photo: Stephen Ralph, D. Allan Bromley, and J. Robert Schrieffer.]

Undergraduates at the DNP Meeting, *continued from page 1*

sented an overview of their graduate school programs. Also on the agenda was a talk by Harry Lipkin on the early days of the quark model, a tour of the Los Alamos laboratory grounds, and a visit to the Bradbury Science Museum in downtown Los Alamos.

According to Warren Rogers, associate professor of physics at Westmont College and the main organizer of the event, student response to the CEU experience was very positive, as was the reception they received from the larger DNP community. "They really enjoyed meeting each other and comparing their research experiences. I think many found it very inspiring and motivating to learn of the research being done by their peers around the country," he said. "They also enjoyed meeting members of the DNP community and discussing research and graduate school opportunities. Their energy and enthusiasm were somewhat contagious, and I think their presence was sincerely appreciated by the larger community."

Sarah Baxter, UNC at Asheville, stands by her poster paper describing research performed at Michigan State University.

Plans for the next CEU at the fall 1999 DNP meeting in Asilomar, CA, are already underway. The CEU home page, complete with a listing of student abstracts, the program of activities, and several photos can be found at http://pulsar.westmont.edu/physics/dnp98/.

THE BACK PAGE

Exploring the Connection Between Physics, Technology, and Economic Growth

by J.C. Tsang, H.D.I. Abarbanel, G.A.N. Connell, L.J. Lanzerotti, and J.D. Sullivan, members of the APS Panel on Public Affairs (POPA)

How does scientific knowledge provide economic value in today's environment. Many of us "think" that this question is trivial. It isn't. Public appreciation of the value of scientific knowledge and physics is critical for continued support for our work. Understanding how concerned non-scientists now think about the economic benefits of such support is fundamental to responding to today's pressures on physics research and education. A detailed understanding of the practical value of physics knowledge in the contemporary economy and the ability to communicate that understanding is essential in justifying future investments in R&D.

Such efforts are necessary because financial support for R&D in the US is substantial. If this support is taken for granted by scientists, it can be significantly reduced or reallocated in ways that we may believe are unproductive. About $215 billion will be spent on R&D by the public and private sectors this year. Throughout the 1990s over 2.5% of the US GDP was spent annually on R&D. Total US R&D expenditures since the late 1970s have doubled. This growth has been driven by industry, which now provides over 65% of all US funding for R&D, reversing past patterns, where about 60% of all US R&D spending was supplied federally.

The $63 billion federal spending on R&D in 1998 is an impressive part of total discretionary federal spending. Even the $15 billion spent annually by Washington on "basic research" is a measurable fraction of discretionary spending. In contrast, total federal funding for the arts and humanities before the wave of interest in deficit reductions was only $350 million. Scientists should ask why they have been able to attract so many more federal dollars. Physicists should also consider the growth in private sector support for R&D over the last two decades and understand the opportunities it presents.

As physicists, we believe that physics education and research benefit society in numerous intangible and tangible ways. The intangible contributions of physics include the satisfaction of the human instinct to comprehend the world in which we live through a fundamental understanding of the physical universe. The contributions of modern physics to many different parts of contemporary life make an unchallengeable case for how physics has enriched the nation. While we may not have built the things we see around us, we know they are based on our ideas. For many of us, the intellectual beauty and anecdotal connections justify the national investment in our educations and work.

While we may wish to justify physics on intangible grounds, we must recognize that more tangible rationales have always been critical to our fellow citizens. There is general agreement that scientific discoveries based on research are often necessary, but almost never sufficient for new technologies and economic growth. While many new products and processes originate in scientific discoveries, the scientific discovery is often not the most "difficult" of the steps leading out of the lab. It is almost never a sufficient step for the civilian marketplace. The "I didn't actually build it, but it was based on my idea" rationale now produces scorn rather than respect.

Two subjects are at the heart of the POPA bibliographic essay on research, technology and economic growth. One is whether the existing organization of research in the US, and the system for its support, provides satisfactory economic returns given the current level of investment in R&D. The second is the effort to quantify the economic benefits of scientific research.

The debate over the first question challenges the traditional distinctions between basic and applied research and the importance of basic research as the major driver of innovation. It suggests that the systems and organizations that were very successful after WWII may require significant modifications to meet today's challenges. This can severely impact support of physics research as we know it.

With respect to the second, there is wide acceptance that research is necessary for economic growth. However, there is not a consensus on how the economic benefits of research can be quantified. The intellectual infrastructure connecting levels of research support to quantitative increases in the GDP does not exist. In contrast, analysts believe that we quantitatively understand the economic consequences of many other investments. Since budgets are quantitative instruments, it is an advantage to be able to relate quantitative results to quantitative inputs. We must take seriously the efforts of economists and policy analysts to quantify the economic contributions of R&D.

The Science-Technology Connection

Our current institutions and policies are solutions to yesterday's challenges and problems. Since WWII, some of these challenges and problems have changed. Occasionally, this can require new solutions. Studies of the role of science and technology in innovation improve our understanding of the contribution of research to economic growth. Understanding in this area traditionally occurs through complex case studies (data) and the creation of simple models (theory) which try to summarize these studies. The models inspire controversy both with respect to internal consistency, and whether they describe reality. These controversies are important because alternate models provide different conceptual frameworks by which policy makers, scientists and engineers view the complex interaction between science, technology, and economic growth.

Many developments in the first half of the 20th century showed the limits of "uneducated, practical" inventors and the need for highly educated innovators capable of understanding and performing scientific and technical studies. This produced a model of innovation, where technical progress began with basic research and "basic research is the pacemaker of technological improvement." Projects producing revolutionary innovations were theorized to begin with basic research, pass through applied research and end in development. This so called "linear model" provides an appealing rationale for the support of basic research. Its underlying assumptions had significant influence on R&D practices and policies in the US for many years after the end of WWII.

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Today, the "linear" model has been abandoned in many policy circles. In the 1970s and 1980s, concern about US performance in the global economy spurred increased interest in the connections between scientific knowledge and economic growth. Reassessments of the "linear model" led to more complicated models of the innovation process, and the role of research in it. These models draw on what are perceived to be unique features of today's economy. These include emphasis on time to market, extreme competitiveness, globalization of design, and manufacturing expertise, etc. All emphasize the importance of applied research, and feedback from users, customers, etc. in driving technological innovation. The rapid, continuous evolution of products described by "Moore's Law" is seen as the major way in which research can contribute to economic growth. Today's understanding of how we now view the connection between scientific knowledge and economic innovation has a critical impact on how support for research is currently justified and structured.

Valuation of R&D

A satisfactory quantitative understanding of how research pays off in the marketplace would allow the direct comparison of the returns on investments in research and other kinds of investments. For physicists who know the history of the transistor, the semiconductor industry seems a splendid example of how research can have enormous economic payoffs. But within the current methodologies of modern economics, there is no generally accepted numerical or analytic model of the contributions of scientific research to quantitative economic growth. The controversies in this field are intellectually challenging and well worth reading.

This problem is closely related to the management of research in business. The dominant methodology of the past has been the calculation of the net present value (NPV) of a project. This technique was designed for investments such as building factories and buying airliners, but is widely criticized as a blunt tool more likely to provide the wrong answer than good guidance for R&D policy.

The emerging field of the quantitative assessment of risk has studied this problem in the last decade and offers a different framework for analysis. The new approach stresses that current research investments provide information allowing for the better use of future investments. From this viewpoint, a research investment is analogous to a financial option. A research investment is viewed as the cost of keeping such an option alive until the decision to go ahead with or cancel the project can be made with greater certainty about the outcome based on the results of the research. Such systematic approaches to investing in research raise challenging questions about how different types of research can be compared, how strategic directions against which the option value of a proposed research activity can be assessed quantitatively are arrived at, and how metrics to assess the impact of the strategic options can be defined.

Conclusion

Anecdotal examples of the value of R&D are basic to any consensus on the value of physics research. They do not, however, help individuals who are trying to understand the additional benefits of a 7% annual increase in federal basic research funding as compared to, for example, a smaller annual increase in research funding, and new tax credits for corporate R&D or increased funding for Head Start, etc. Even in an era of budget surpluses, choices like these will have to be made. A better understanding of how R&D contribute to our economy, and the development of metrics that quantify these contributions would make trivial the justification of R&D to our fellow citizens.

For the present, however, physicists must be realistic about the kinds of arguments we can present. We can clearly point to where we have had great intellectual impact but must recognize that our economic impact has generally come as part of a community of scientists, engineers, and technically minded individuals. If we work together with our professional colleagues, accept that many of the choices involved in the crafting of science and technology policy are political choices, and are prepared to engage in the political process by which policy choices are made, we now know enough about the economic impact of physics research and education today to feel comfortable, though not complacent, about the economic future of our profession.

The above is a summary of a recent bibliographic essay produced by the Science, Technology and Economic Growth Committee of the APS Panel on Public Affairs (POPA). The full report, with complete citations of source material can be found on-line at www.aps.org/public_affairs/popa/steg.html .

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