APS NEWS

January 2002
Volume 11, No. 1

A Publication of The American Physical Society http://www.aps.org/apsnews

CONTRIBUTE to September 11 Scholarship Fund
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New Hadronic Physics Topical Group Approved

The APS Council approved the formation of a new topical group on hadronic physics at its November meeting. Hadronic physics is the study of strongly interacting matter, and incorporates such subfields as quantum chromodynamics, relativistic heavy ion physics, and lattice gauge theory.

The underlying questions which drive the field have deep potential impact on nuclear physics, high energy physics, astrophysics and cosmology.

"Thirty years ago, hadronic physics formed an integral portion of high energy particle physics," says Eric Swanson of the University of Pittsburgh, one of the new topical group's founding members. "Since then, particle physics has moved on to Higgs energy scales and hadronic physics has spun off as a separate field. Unfortunately, this is not recognized in the structure of the APS or by the funding agencies. The result is a scattered and disenfranchised community."

In journals, conferences, and advisory panels, hadronic physicists often find themselves bundled together with particle and nuclear physicists, although neither area is primarily concerned with the issues that

See HADRONIC *on page 6*

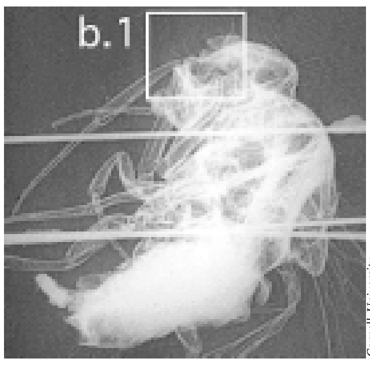
San Diego Fellows Gather

Sarah Davis/APS

At its November meeting in San Diego, the APS Executive Board met with area Fellows, in a social occasion embellished by remarks by then APS President George Trilling and Executive Officer Judy Franz, and a description of the PhysTEC program by Education Director Fredrick Stein. Here George Trilling (center) chats with APS Fellow and former Caltech classmate Carl Rouse of Rouse Associates (right) while William Frazer, chair of the Panel on Public Affairs, looks on.

Latest Fusion Research Featured at DPP Meeting

How can a little bit of geometry improve microwave cooking? What encouraging news has the largest unclassified supercomputer provided on fusion energy? These and many other questions were addressed at one of the APS's largest physics meetings this year: the 43rd annual meeting of the Division of Plasma Physics (DPP), held from October 29 - November 2, 2001 in Long Beach, California. Almost 1,600 papers were delivered at the meeting, covering a broad range of topics in plasma physics research.



Cornell University

Intricate details emerge in this radiograph of a fruit fly produced with the flash emitted by an X-pinch plasma.

X-Pinch Flash Illuminates Flies

Researchers at Cornell University have used the brilliant burst of x-rays emitted by vaporizing wires to create striking images of tiny subjects, including houseflies and fruit flies. The radiographs help to demonstrate the characteristics of the flash that erupts when 100,000 amps of current are rammed through the crossed wires of an X-pinch machine. When a current courses through X-pinch wires, they vaporize into plasma. The plasma continues to guide the current, which in turn generates a magnetic field that confines the plasma.

As the current increases, the magnetic field grows and the plasma implodes, typically resulting in one or two dense plasma points less than a thousandth of an inch across with temperatures as high as 10 million degrees centigrade. The unstable plasma points first emit bursts of x-rays that last less than a billionth of a second and then explode. Bright, point-source x-ray bursts generated by the X-pinch machine are ideal illumination for radiographs of thin objects. Details on the order of a few millionths of a meter, such as the hairs on a fly's wing, would be impossible to discern with larger x-ray sources, but are clearly visible in images created with X-pinch flashes.

See DPP MEETING *on page 6*

Council Seeks Units' Advice in Raising All Prizes to $10,000

Acting on a recommendation of the Task Force on Prizes and Awards, the APS Council at its November meeting moved one step closer toward requiring all major APS Prizes to carry a minimum stipend of $10,000 by the end of 2006. It will revisit the issue at its next meeting in April, after the various units that would be affected have had a chance to offer their advice.

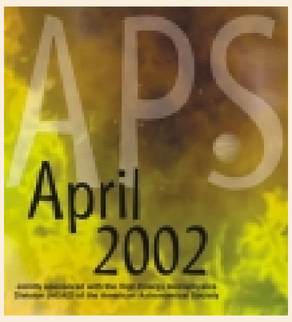
While six Prizes are already at or above this level, the remaining twenty are not, with current stipends ranging from $7,500 down to $3,000. If Council passed the requirement, the way to meet it would boil down to the following choices: (a) raising the additional resources needed to bring the Prize up to $10,000; (b) allowing a Prize that is currently given annually to be awarded less frequently; or (c) allowing a Prize to be reclassified as an Award, which in the APS system is less prestigious and not subject to the monetary restriction. Some Prizes might even disappear altogether.

The motivation for the recommendation is the feeling that anything less than $10,000 is no longer a significant sum for a major Prize, according to Myriam Sarachik, APS President-elect and Chair of the Task Force. "This is especially clear when the stipend is divided among several recipients," she added.

Sarachik noted that, for example, the Buckley Prize in condensed matter physics is one of the oldest and most prestigious of the APS Prizes, but its $5,000 stipend is the

See ADVICE *on page 3*

Albuquerque Will Host 2002 April Meeting



Physicists from across the country will head to the Southwest for the 2002 APS Spring meeting, to be held April 20-23 in Albuquerque, New Mexico. Traditionally dominated by topics in astrophysics, nuclear physics, and particle physics, and related scientific fields — such as plasma physics and beam physics, for the first time the meeting also has joint sponsorship of the High Energy Astrophysics Division (HEAD) of the American Astronomical Society. The 45 invited sessions and more than 100 contributed sessions will also feature talks in such non-scientific topics as the role of physicists in anti-terrorism, the history of Los Alamos, and communicating with elected officials.

The scientific program will feature nine invited plenary talks on a wide range of topics, including a summary of the first results from the Relativistic Heavy Ion Collider at Brookhaven, and the Sloan Digital Sky Survey. Other talks will focus on universal scaling laws in biology, medium-sized black holes, X-ray studies of globular clusters, the solar neutrino problem, the new landscape for CP violation, and theories of the cosmological constant.

Among the scheduled special events is a tour of the Very Large Array (VLA), one of the world's premier astronomical radio observatories. The

See APRIL MEETING *on page 3*

POPA Issues Status Report on Outlook for Nuclear Energy

Nuclear energy has suffered a negative image in public perception in decades past, but the outlook for the industry has improved considerably in recent years, according to a new report commissioned by the APS Panel on Public Affairs (POPA). Entitled "Nuclear Energy: Present Technology, Safety and Future Research Directions," the report notes improved economic and safety features in existing nuclear power plants, with further improvements expected to be achieved from new designs now on the table. However, competing economically remains a challenge, as do such issues as waste disposal and plant security.

"The beginning of the 21st century marks a critical time for nuclear energy, arguably one of the defining technologies of the 20th century," the authors write. The first commercial nuclear energy plant was built in Shippingport, PA, at the end of 1957, and today there are currently 438 nuclear power plants operating worldwide, 103 in the US. Nuclear energy provides 20% of US electricity and roughly 17% worldwide. This development was largely driven by increasing demand for energy as well as the price spikes and volatility of energy costs in the 1970s and early 1980s.

Historically, US plants have cost more to build, with longer construction times and lower capacity factors (plants were generating electricity at less than 70% of their total capacity). However, while no new plants have been ordered in the US, the subcommittee found that the economic outlook for nuclear power has improved dramatically. Capacity factors are now close

See POPA *on page 4*

Highlights

Members in the Media

"There is awesome resistance for the system to change. But I think this is a better way to teach physics. Once you reduce the math, physics is harder to teach and maybe that's part of the problem."
—Leon Lederman, Fermilab, on teaching physics in the freshman year of high school, San Diego Union-Tribune, November 11, 2001

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"You have to pay attention when something challenges the standard model. But I'd be reluctant to call this new physics until others confirm the experiment."
—Jonathan Rosner, University of Chicago, on results from Fermilab's NuTev experiment, USA Today, November 12, 2001

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"The actual effect is more complicated than we thought previously. Air pressure plays an important part, irrespective of the density of the grains. Our results indicate an intricate interplay between vibration-induced convection and fluidization, drag by interstitial air and intruder motion."
—Sidney Nagel, University of Chicago, on why large nuts rise to the top in a can of mixed nuts, the Independent (London), November 15, 2001

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"His experience has been desperately needed. He is remarkably well-suited to the task."
—D. Allan Bromley, Yale University, on the appointment of Donald Henderson to head the new Office of Public Health Preparedness, Dallas Morning News, November 18, 2001

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"A little mouse may only live two or three years, and a whale may live roughly 60, but they have the same number of heart beats. And that is roughly a billion. It's as if an organism of a given size has its own internal clock ticking away."
—Geoffrey West, Los Alamos, on the use of scaling laws to explain biological systems, Santa Fe New Mexican, November 19, 2001

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"Since emission can now be detected at the single molecule level, the use of these green fluorescent proteins can lead to nano-devices in which the memory cell is composed of just one protein."
—Vittorio Pellegrini, Scuola Normale Superiore, Pisa, on the possibility of biological memory devices, Electronics Times, November 19, 2001

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"When I left, Iraq had already built part of its biological program and was already synthesizing and making biological agents. And....Iraq continued even after the destruction of the Gulf War and the presence of inspectors who were hounding Iraqi scientists all over Iraq, it still managed to rebuild parts of its biological program."
—Khidhir Hamza, Fredericksburg, VA, CNBC Hardball with Chris Matthews, November 19, 2001

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"It was easier in World War II because there wasn't a standing bureaucracy. Now we have such a big defense infrastructure. People are going to argue, 'That's my turf!' It's going to be extremely difficult."
—Richard L. Garwin, Council on Foreign Relations, on whether scientists can have an impact on government policy, New York Times, November 20, 2001

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"Homestake provides depth, great depth, the primary criterion for a national underground science laboratory."
—John Bahcall, Institute for Advanced Study, on whether to build a new underground laboratory in South Dakota, New York Times, November 24, 2001

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And finally, two comments on the accident at Super-Kamiokande that destroyed most of the photomultiplier tubes:

"It will probably take more than a year and enormous costs to repair, and that will mean the world's neutrino studies will lag behind in the meantime without this unique detector, the world's largest."
—Masatoshi Koshiba, University of Tokyo, Asahi News Service, November 14, 2001

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"We're determined to rebuild the detectors."
—Yoji Totsuka, University of Tokyo, Associated Press, November 13, 2001

This Month in Physics History

January 1665: Publication of Hooke's Micrographia

Few classic scientific publications have enjoyed the lasting impact of Isaac Newton's *Principia* or Charles Darwin's *Origin of the Species*, but one that is often neglected is the *Micrographia*. Its author, Robert Hooke, was one of the most brilliant and versatile of 17th century English scientists, albeit lesser known than his contemporary, Newton. Apart from its inarguable scientific importance, *Micrographia* opened up a hitherto invisible universe to the general reading public.

Born on the Isle of Wight to a curate, Hooke was initially destined to become an artist, apprenticed at 13 to the leading portrait painter of the age. But he complained that the oils and varnishes irritated his chest, and left to attend Westminster School, where he acquired mastery of ancient languages, learned to play the organ, experimented with flying machines, and is said to have mastered the first six books of Euclid's *Elements* in a week. In 1653 Hooke became a chorister at Christ Church, Oxford, where he met the men who would later found the Royal Society. In 1658 he became assistant to Robert Boyle, applying his mechanical skills to the constructions of an improved version of an airpump, and gaining a thorough mastery of chemistry and practical laboratory skills.

Four years later, Hooke was appointed curator of experiments to the newly founded Royal Society, responsible for the experiments performed at its weekly meetings. In 1665 he was finally hired as a professor of geometry at Gresham College, making him the first salaried research scientist in Britain. Between 1661 and 1664, he conducted a series of observations and experiments using a microscope which formed the basis for the *Micrographia*.

Micrographia first appeared in bookshops in January 1665 and had an immediate sensational impact. For scientists, it provided not only a wealth of new data but an articulate and beautifully presented justification for experimental science. For example, a simple observation of a piece of charcoal under the microscope could lead to a recognition of the presence of cells. The anatomical description of a fly developed into an experimental essay in aerodynamics, acoustics and wave patterns. Indeed, every one of the 60 observations in the *Micrographia* are detailed starting points for further physical investigations, accompanied by 58 stunning engravings. Hooke's artistic gifts proved essential to the realization of the work, enabling him to faithfully interpret and delineate the awkward images produced by the compound microscopes of the 1660s.

The book had an equally powerful impact on the laity, in large part because of the accessible writing style and ample illustrations, which offered an arresting new perspective on common and familiar objects: a fine needle point looked like a rough carrot, delicate silk looked like basket work, and extinguished sparks resembled lumps of coal. Samuel Pepys claimed he pored over the volume until 2 AM, declaring it "the most ingenious booke that ever I read in my life," and he later bought his own scientific instruments and joined the Royal Society, eventually becoming its president in 1684.

While Hooke's later work in optics and gravitation was overshadowed by the contributions of Isaac Newton, he was unsurpassed in his time as an inventor and designer of scientific instruments. For instance, he invented the spring control of the balance wheel in watches; the compound microscope; a wheel barometer; and the universal joint found today in all motor vehicles: the "Hooke's joint." He was among the first to insist on the importance of resolving power in astronomical instruments, and built the first reflecting telescope, using it to observe the rotation of Mars and note one of the earliest examples of a double star. And he was an accomplished architect, designing many London buildings, although only a few survive.

In his later years, Hooke's health deteriorated, and he suffered from numerous symptoms of cardiovascular disease and diabetes: swollen legs, chest pains, dizziness, emaciation and blindness. He died on March 3, 1703. While he enjoyed a measure of worldly success, his reputation suffered from his many controversies with other scientists, including one with Christiaan Huyghens over the spring regulator, and with Newton, first over a question of optics and later over priority in the formulation of the inverse square law of gravitation. Always prickly where his pride was concerned, he eventually grew embittered, melancholy and distrustful, feeling that he had been cheated by Newton of his proper eminence in society.

While Hooke never achieved the same recognition as Newton, he was nevertheless a figure of extraordinary and diverse creativity, combining a solid grasp of ancient languages, highly skilled draughtsmanship and practical craft skills. But most of all, according to Oxford University historian Alan Chapman, "He was the man who showed that the 'experimental philosophy' actually worked and could be used to extend the bounds of natural knowledge. He was Europe's last Renaissance man, and England's Leonardo."

Above photo: Hooke memorial window, St. Helen's, Bishopsgate, City of London.
[http://www.roberthooke.org.uk/robert_hooke.htm]

APS NEWS

Series II, Vol. 11, No. 1
January 2002

Coden: ANWSEN ISSN: 1058-8132

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Design and Production .... Alicia Chang
Proofreaders .... Ken Cole, Edward Lee and Sue Otwell

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

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

Subscriptions: *APS News* is an on-membership publication delivered by Periodical Mail. Members residing abroad may receive airfreight delivery for a fee of $15. Nonmembers: Subscription rates are: domestic $105; Canada, Mexico, Central and South America, and Caribbean $105; Air Freight Europe, Asia, Africa and Oceania $120.

Subscription orders, renewals and address changes should be addressed as follows: For APS Members—Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org.
For Nonmembers—Circulation and Fulfillment Division, American Institute of Physics, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502. Allow at least 6 weeks advance notice. For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing issues will be honored without charge only if received within 6 months of the issue's actual date of publication. Periodical Postage Paid at College Park, MD and at additional mailing offices. Postmaster: Send address changes to *APS News*, Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Brinkman Outlines Priorities, Challenges for APS in 2002

Editor's Note: Incoming APS President William Brinkman, retired vice president of research at Bell Laboratories/Lucent Technologies, assumed leadership of the Society on January 1st, succeeding George Trilling (Lawrence Berkeley National Laboratory). In the following interview, he offers APS News his thoughts on the priorities and challenges facing the APS in the coming year.

Q *You've served for the last two years as APS vice president and president-elect, and hence are familiar with the Society's current slate of activities. What do you view as the top priorities for the APS in the coming year?*

A The primary role of the APS is organizing the publications and the meetings. The APS operating officers have done an excellent job over the last few years in bringing the APS journals online and in completing the PROLA archives (see *APS News*, August/September 2001). There are now virtual journals coming into existence that make it easy to follow a specific subject. In addition, the cross-linking of references makes searching the literature much faster and more efficient. The APS deserves a lot of credit for leading in this transition but we must continue to think through the impact of new technology on our publications.

In the education arena, the new PhysTEC program spearheaded by Fred Stein is going to be a major thrust this year, as we explore the possibility of bringing together education departments and physics departments to create a better curriculum and better-trained science teachers for K-12. As an effort to serve the nation, the APS-sponsored study on national missile defense (see *APS News*, January, March and October, 2001), focusing on boost-phase intercept technology, is a very important activity in terms of helping people understand what is possible in missile defense. Prior studies, such as that on Directed Energy Weapons, have left a permanent mark on national defense policy.

Q *What are the predominant challenges?*

A In our publications, we need to rethink the role of refereeing for the *Physical Review* and *Physical Review Letters*. Before the internet, the publication of a paper was sufficiently expensive that it was important to make sure whatever was published was of high quality. Today, the cost of putting a paper on the web is very small so ensuring the quality is not as important as it was. Almost every physicist I talk to uses the Los Alamos preprint site and doesn't mind the fact that the papers on it are not refereed. We haven't responded to the implicit message contained in the success of this site. What is the proper role of refereeing? Many people think the refereeing process is vital to maintaining the quality of our journals; others think it could be done away with entirely. Still others think that a new process should be put in place where expert opinion is used to guide people to the important papers on the subject. We need to have an open debate on this issue in the coming year.

Given the rapid changes that are already occurring, we're wrestling with the question of how to maintain our journal revenues in an online world. The journals are growing at between 3.5-4% per year, and costs continue to rise. We must find a way to continue the revenues that traditionally came from libraries for paper versions of our journals. We are gradually moving to a use-based charging scheme and perhaps that is the sensible answer.

There has also been some concern expressed about the organization of meetings, namely that they do not seem to encourage cross-fertilization between subfields. But at the same time, the divisions and topical groups have made their own decisions about how they want to meet, and the Society has responded to the desires of the people involved. I do not know how to solve this conflict.

Q *There has been much talk in recent years of the end of the dominance of physics among the sciences in favor of biology, bolstered by declining numbers of students and federal funding. How do you view the situation?*

A The question often arises as to whether physics is in some sort of malaise. The number of students has decreased and to many it seems like a mature field with less relevance to modern society than it has in the past. I think this is true to some extent. Many of the problems we're examining today are not going to affect individual human lives directly: the anisotropy of the black body radiation, neutrino oscillations, organic single crystals. But they are all intellectually fascinating and one never knows. We should recognize that while some problems, such as the discovery of the transistor or understanding the difference between a metal and an insulator, were particularly closely tied to industrial progress, others more remotely connected to products may provide the breakthroughs for the future. We should be proud of what we are doing and contributing, and share the excitement when we find new things.

I also believe that physics training teaches one to question answers and assumptions and that physicists tend to do well in a broad range of jobs using their strong understanding of the basic physics.

Certainly funding for physics research has been on the decline. The APS has worked very hard to create a Washington office that effectively addresses this issue. The staff there has done an excellent job of educating APS members about what's going on in Washington and recruiting them to write their Congressional representatives to alert them to important issues in science funding. The Washington office has also established itself as a reliable source of information for many members of Congress. The APS should continue to be involved in public affairs issues related to the concerns of our members, particularly the health of the physics research enterprise. We're trying to expand our activities in this area through our involvement in an advocacy organization called ASTRA, which is focused on support for the physical sciences.

Q *Obviously the tragic events of September 11, 2001, have had a tremendous impact on the entire country. How is the APS responding to the current national need?*

A We're trying to determine the proper response to the anti-terrorism efforts of the US government. There could be areas where the APS and other professional scientific organizations can help, whether it's creating lists of experts or conducting a study centered around some aspect of terrorism. Basically, we need to determine whether there's some physics-related issues that could be studied that would help the nation in its fight against terrorism.


William Brinkman

In a more immediate response to the tragedy, we are offering our members the opportunity to contribute to a new charitable fund that is establishing a scholarship fund for the survivors specifically directed towards education in science and technology (*see page 7*).

Q *In recent years the APS has sought to better address the needs of its industrially employed members through the formation of the highly successful Forum in Industrial and Applied Physics. Coming from an industrial perspective yourself, why is this important, and how might the APS continue its outreach efforts?*

A A very large fraction of physicists are employed in industry today, and work on many different things. They are a large percentage of the membership of the APS. Many are working at jobs that are not closely related to physics research, but still find it interesting to hear about the latest results. So it's very important for the APS to continue to reach out to them. FIAP does this well.

Q *One of the strengths of the APS is the dedication of its many volunteers, including members of the presidential line. Why do busy scientists such as yourself devote so much time and energy to furthering the Society's objectives and activities?*

A All of us feel some social obligation, as part of the physics community, to participate in the activities of the APS. We find it interesting to associate with our colleagues in the Society and therefore we do not mind doing voluntary work. You get to meet a broader spectrum of physicists than you might otherwise, and to learn what they do not just in physics research, but in other activities that are related to it. So it provides a broadening of perspective and I think people like myself enjoy that aspect of volunteerism.

Brinkman at a Glance

- Received PhD in physics from University of Missouri in 1965.
- Joined Bell Laboratories in 1966 after one year as an NSF Postdoctoral Fellow at Oxford University.
- After serving in various positions, became vice president of research in 2000; retired in September of last year. Previously, responsible for directing research in physical sciences, optoelectronic and electronic devices, and fiber optics.
- Personal research in theoretical condensed matter physics, including theory of spin fluctuations in metals, metal-insulator transitions and superfluidity in He3.
- Recipient of the 1994 George E. Pake Prize

April Meeting, *from page 1*

VLA consists of 27 radio antennae, each 25 meters in diameter and weighing 230 tons, distributed in a Y-shaped configuration. The data collected from the antennae is combined electronically to improve resolution and sensitivity to levels of a much larger system.

Several other local tours will also be available for attendees, including a tour of Sandia Mountain, which dominates the east side of Albuquerque with its 5,000 foot vertical rise. The city is also the hot air ballooning capital of the world, and individual balloon flights over the Rio Grande Valley are available. Finally, attendees can opt to tour a 70-acre pueblo atop a mesa where the Acoma Indians have lived for nearly a thousand years.

Advice, *from page 1*

same as it was in 1972, when that amount was much more significant. The Prize currently has an endowment of more than $150,000, meaning the requirement could be met by raising the less than $50,000 needed to bring it up to $200,000. APS policy allows 5% of the endowment to be spent annually on the stipend of the Prize.

Even closer to the goal is the Bethe Prize, which currently has a stipend of $7,500 and an endowment of $195,000. The units associated with this Prize are Nuclear Physics and Astrophysics.

At the opposite end of the spectrum is the Plyler Prize for Molecular Spectroscopy, which has a rich tradition going back to 1977. It has no endowment at all, and has been funded by annual grants from the Crouch Foundation. Recently, however, the foundation informed APS that their resources did not permit maintaining the Prize at its $5000 level, necessitating a reduction in the stipend to $3000. Thus the APS would either have to raise the full $200,000 endowment, or else find another funding source willing to offer annual support at the $10,000 level.

Several other Prizes are similar to the Plyler Prize in that they are not endowed but rather rely on grants from foundations or from companies. These must be renewed periodically, which can sometimes lead to sudden loss of support, as happened recently to the Maxwell Prize in Plasma Physics, when the company supporting the Prize went out of business. Members of the Division of Plasma Physics were fortunately able to secure alternate funding, and there are plans to begin raising an endowment for the Prize.

The Task Force on Prizes and Awards was established last summer to survey a broad range of issues concerning the APS honors program, as reported in the August/September *APS News* (http://www.aps.org/apsnews/0801/080110.html). Its report includes ten other recommendations besides the one to raise the monetary level of prizes.

Sarachik noted that the recommendation for higher stipends was also a feature of an earlier task force report, in 1998. "The $10,000 lower limit on Prizes is long overdue," she stated, and added that the Task Force will now canvass the units to get their views, and then report back to Council. Members of these units, or other interested parties, are also urged to contact members of the Task Force if they wish to express an opinion. The contact information for Task Force members is available on the APS web site at http://www.aps.org/praw / taskforce/tf-members.html.

LETTERS

Investment in Physics is Fundamental

The articles on physics and society recently published in *APS News* present important points of view on fundamental research in physics. However, they fail to present the perspective of a Congressional appropriator or a federal program officer.

Science in general, and physics, in particular, are expensive. In 2000, a $100,000 research grant consumed 12 average income tax returns. Any conscientious public servant wishes to see the public receive maximum return on its investments. Applied research promises returns on that investment in the foreseeable future (5-10 years). Fundamental research, if it is truly fundamental, cannot promise economic returns. When researchers try to do so, their arguments become so tenuous that thinking people question them with good reason.

Thus the case for investing in fundamental research must be that it fills our intellectual stockroom with knowledge of the world around us. Twenty or fifty years in the future, an industrial developer can pull these concepts, experimental results and techniques off the shelf for economic benefit. Physicists cannot foresee what research will be economically important any more than investment counselors can tell exactly which start-up will become the next IBM.

Physicists must make the case that investment in fundamental knowledge of our world will provide the foundation of future economic security even though they offer no sure economic return in the short run. We cannot expect busy public servants to understand the nuances of cutting edge physics research nor can we make emotional appeals promising miracle cures for terrible illnesses. Instead we must appeal to the good business sense and sincere concern for the future of the country that characterize elected and appointed public servants.

Ruth Howes
Ball State University

Whose Hand?

Reference is made to the article on W. Roentgen and the discovery of X-rays in the November *APS News*. It looks like you are propagating an error concerning the x-ray shown on the bottom of the page. The x-ray shown is not an x-ray of Roentgen's wife's hand, and I doubt very much that it was taken on November 8th 1895, the very day that Roentgen discovered X-rays.

The same error appears in the July 19, 2001 "U.S. News and World Report", where, on page 58, the same x-ray is identified as that of Mrs. Roentgen's hand.

The x-ray in question is actually that of the hand of Professor von Kolliker of Wurzburg's Physical Institute and was taken on January 23, 1896. You can find this correctly identified in several places, among them in "The Story of X-Ray", published in 1963 by the General Electric Company X-Ray Department in Milwaukee, Wisconsin.

If you want to see an actual x-ray of Mrs. Roentgen's hand, refer to page 6 of "Radiologic Science for Technologists" by Stewart Bushong published by Mosby in 1980. Comparing the two x-rays, one sees that the they are clearly different, particularly with reference to Mrs. Roentgen's ring, which is not that of Professor von Kolliker. And how about the size of her hand in the misidentified picture...rather large for a female isn't it?

Joseph A. Keane
Pearl River, New York

Alternative Theory to Eliminate Tornadoes

To eliminate tornadoes on Earth, require all driving to be on the left in the Northern hemisphere and all driving to be on the right in the Southern hemisphere. This follows from the theory that the seeds of tornadoes arise when cars and trucks pass each other in opposite directions on the highways. These passings result in local vortices which can be either amplified by the Coriolis Effect if the senses of the two rotations are the same or damped out if the senses are opposite. Since the Coriolis Effect results in counter-clockwise rotation in the Northern hemisphere, one would want the driving to be on the left to produce tornado seeds that are rotating clockwise.

Alan C. Cummings
Pasadena, California

zero gravity
The Lighter Side of Science

Tenureclocky

by Dany Adams, Department of Biological Sciences, Smith College, Northampton, Massachusetts. Drawing by Lois Malone (with apologies to Lewis Carroll)

"She's Brilliant!" so the Ivy grove
Did hire the nimble minded maid.
All flimsy were her bookish robes
Her bona fides displayed.

***

"Beware the Tenureclock, young one,
Don't pause at night or flaws they'll catch.
Be sure you publish blurbs, and shun
The populous intro class!"

***

She took an undergrad in hand.
Long time the grant of dough she sought.
And tested she her theory.
And swelled a file. And taught.

***

And as she published what she could,
The Tenureclock, with eyes of flame,
Came sniffing round for moldy wood
And prospecting for fame.

***

"No clue what's due? You're never through!"
The maid's keyboard went click and clack.
She felt half dead, but pushed ahead
Around the tenure track.

***

And did she tame the Tenureclock ?
Overcome all academic strife ?
She's taken her MacArthur grant
And gone to get a life.

***

"She's Brilliant!"so the Ivy grove
Did hire the nimble minded maid.
All flimsy were her bookish robes
Her bona fides displayed.

Passing the Torch

Amy Halsted/APS

After a 30 year career as an APS editor, Gene Wells retired on 7 November 2001. Wells received his PhD in condensed matter physics from the University of North Carolina, Chapel Hill in 1969, and has been an Editor of Physical Review Letters in the area of condensed matter for some 20 years. Wells will relocate back to North Carolina with his wife Diana, the better to indulge their shared passion for golf. Once settled, he plans to work part time for APS as a remote editor.

Wells also held the position of Managing Editor for PRL, a responsibility now taken on by Reinhardt Schuhmann, known as Reiny. "Gene has been an exceptional editor, and he will be missed," said Schuhmann. "With the benefit of his tutelage and with the continued efforts of our excellent staff, we will strive to maintain the high standards he set." In the photo at left, at a party in his honor, Wells and Schuhmann hold a plaque presented to Wells of the cover and masthead of PRL.

POPA, *from page 1*

to 90%, plants are being assessed at dramatically higher values than in the past, and the Nuclear Regulatory Commission expects three-quarters of operating plants to apply for license extension, providing an additional 20 years of operation. Furthermore, recent attention to the environmental effects of fossil fuel use — including global warming and local air quality — has rekindled interest in the prospects for expanding the nuclear industry.

The majority of the subcommittee's report focused on safety concerns, which have been a major criticism of nuclear power, and on some of the new designs for reactors that are being developed to address those concerns. "The most important aspects of preventing harm from the radioactivity are the functions of reactivity control and heat removal," the report states. "If both of these can be accomplished in an accident, then the radioactivity within the reactor can be contained; if they cannot, it will not be." Thus, for a reactor to be deemed acceptably safe, it must be possible to shut down the nuclear chain reaction and maintain it in a shutdown condition, and also to remove the thermal energy in the reactor to a safe heat sink.

Different reactor designs accomplish these vital safety functions in different ways. Several new advanced light water reactor (ALWR) designs have been developed over the last decade, all of which are based on the technology used in the pressurized light water reactor (PWR) and boiling water reactor (BWR) commercial power plants in operation today. These new designs incorporate many improvements over existing plants in safety, reliability and operability. For example, new safety features have reduced the probability of a core damaging accident by a factor of ten or more. Designs have been simplified, leading to capital cost reduction and streamlined operation. And the cost of electricity generated from these plants has been improved, about 20% lower than today's nuclear plants.

Waste remains a troubling problem, since spent fuel contains highly radioactive materials and must be carefully shielded for several centuries. Currently, spent fuel is stored at the reactor site, and the Department of Energy is decades behind the legislated schedule for developing a geologic repository. And despite the improved economics, "the capital cost is still too high to be competitive with gas-fired plants in the US rate deregulated market, requiring continued efforts to bring down the capital costs," the authors conclude. In fact, "The cost of nuclear power plants has been perhaps the dominant reason nuclear power stopped growing in the US." The terrorist attacks of September 11,2001, have heightened the levels of security around operating plants, and additional security requirements may be imposed, increasing operating costs.

The Department of Energy's Generation IV Initiative is focused on developing one or more next-generation nuclear energy system that can be commercially deployed no later than 2030, offering significant advances in sustainability, safety and reliability, as well as economics. International partnerships will be a vital component of the development process. However, the report concludes, "It remains an open question whether the advances in nuclear power achieved over the last decade can be utilized to develop a nuclear fuel cycle that meets the proliferation concerns and provides the obvious safety and economic advantages needed to develop support in the industry, among investors, and in the general public."

The full text of this report can be found online at http://www.aps.org/public_affairs/popa/reports/index.shtml.

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Fellows Hold Steady on Hill During Tumultuous Year

Last year, two physicists, Brendan Plapp and Sherri Stephan, brought their scientific expertise to Washington as APS Congressional Fellows, tackling such issues as ballistic missile defense, nuclear nonproliferation, and bioterrorism. They also were on hand to witness one of the closest presidential elections in American history; an historic shift in the balance of Congressional power with the defection of a key senator from the Republican party; and an unprecedented terrorist attack on American soil on September 11, whose aftereffects are still reverberating through Capitol Hill.

The rationale for the APS Congressional fellowship program is that public policy increasingly is determined by technical considerations. Science is a major component of many issues with which Congress must grapple: global warming, energy policy, defense technologies, AIDS, pollution, communications technologies, and many, many more. The program provides a public service by making available individuals with scientific knowledge and skills to Members of Congress, few of whom have a technical background. In turn, the program enables scientists to broaden their experience through direct involvement with the summer intern legislative and political processes. Fellows gain a perspective which, ideally, will enhance not only their own careers but also the physics community's ability to more effectively communicate with its representatives in Congress.

Brendan Plapp spent his fellowship year as a legislative assistant in the office of Rep. Edward J. Markey (D-Mass.), working on such issues as nuclear nonproliferation of weapons and environmental concerns. "Even as an undergraduate in Iowa, I was interested in not just doing science, but also in the fact that the physics community has always been very active and involved in international issues, particularly related to nuclear weapons," says Plapp, who studied at the University of Illinois and Cornell with such luminaries as Hans Bethe and Kurt Gottfried.

One highlight for Plapp was working on an amendment to the proposed energy bill, which would have opened up the Arctic National Wildlife Reserve for oil exploration. Markey's office introduced an alternate bill earlier this year to designate the region a wilderness refuge area which was subsequently defeated in Congress. In the area of national missile defense, Plapp helped Markey's office prepare a bill requiring adequate testing of potential countermeasures before fully deploying such a system. Those efforts are now on the back burner. Since September 11th, the focus of Plapp's work has shifted to safety and security of nuclear power plants, primarily on the Nuclear Regulatory Commission's oversight of the industry.

Plapp described his year on the Hill as "absolutely unforgettable"—so much so that APS extended his fellowship to the end of 2001. He has decided to stay on in Washington, and has been exploring the available options in the House and Senate, as well as among scientific societies, many of which employ scientists in government relations and public communication capacities. "I'm exceedingly grateful to the APS for the opportunity," he says. "I'd always been interested in political issues, and I probably wouldn't have had the guts to do this on my own. This program provides an important opportunity for physicists like myself to get out of the laboratory and into the political process."

Sherri Stephan worked with the Senate Governmental Affairs Committee, specifically on the minority staff of the Senate Subcommittee on International Security, Proliferation and Federal Services. She was hired initially because her astronomy background meshed well with the committee's interests in ballistic missile defense and managing the military's space defense assets, as well as the potential for using satellite data for remote sensing. But because of the subcommittee's broad jurisdiction, she found herself involved with nuclear proliferation and chemical and biological weapons, as well as compiling data on the shortage of scientists and engineers in the federal government and assessing its impact on national security.

Like Plapp, Stephan found the focus of her work shifting in the post-September 11 environment, although terrorism and homeland security has always been a significant part of the committee's responsibilities. "After the attacks, those issues came to the forefront and became the priority for everyone," she says. "Our staff was a little bit ahead of the learning curve for a lot of those issues because we'd already been working on them." For example, the anthrax scare that hit Capitol Hill in October proved less disruptive among committee staff members than in some of the Congressional offices, and Stephan was on hand with solid scientific information to help assuage fears. "We've always said that bioterrorism would be very effective for killing a small number of people and terrorizing a lot more, but not very good for killing large numbers of people," she says. "But it is scary, and any death is tragic."

Despite such uncertainties, Stephan has also chosen to remain in Washington, DC. The subcommittee offered her a permanent position last spring, enabling her to follow through on the work she accomplished during her fellowship year. And it keeps her in the same geographical region as her husband, a physicist with the Naval Research Laboratory. "It's been a strange year, very atypical for a fellow, and it keeps getting stranger," she says. "But it's still a great place to work."

Applications for next year's Fellowships are now being accepted. Details can be found on page 7.

Sub-Panel Pushes New Linear Collider for High-energy Physics Research

By Richard M. Todaro

The US should take the lead in the next generation of high-energy physics research by funding the construction at home of an electron-positron linear collider, and it should commit to "vigorous long-term" research and development on a range of other particle accelerator projects, according to the recommendations of a draft report issued by a government advisory panel.

Declaring that "particle physics stands at the threshold of a new era of discovery," the draft report states that such projects have the potential to answer some of the most profound questions ranging from the existence of the Higgs particle (believed to give fermionic particles like leptons and quarks their mass), to the existence of various higher dimensions (as predicted in string theory), to the exact nature of the mysterious dark matter and dark energy (which are believed to fill the Universe and hold the key to its ultimate fate).

The report by the joint Department of Energy (DOE) and National Science Foundation's High-Energy Physics Advisory Panel (HEPAP) was released in late October, and a final report is scheduled for January 2002 release. Written by the HEPAP Sub-Panel on Long-Range Planning for US High-Energy Physics, the report is intended to serve as a 20-year road map that will prioritize what the panel feels are the most important projects for the international high-energy physics community.

Because the US Government provides so much money to high-energy physics research – about $700 million from the Department of Energy and another $50 million to $80 million from the National Science Foundation (NSF) for this year alone, according to statistics provided this past summer from the two organizations — the panel's priorities will help determine how large amounts of research dollars and human capital will be spent in the future. In the case of projects that the draft report "cannot recommend funding for…at this time," the individuals involved were very concerned and are now anxiously waiting to see what the final report states.

Jonathan Bagger of the Johns Hopkins University, co-chair of the HEPAP sub-panel, said the two key elements in the draft report were the 20-year roadmap and five specific recommendations, chief of which is the call for construction of a linear collider in the US. As part of the roadmap, the draft report calls for the creation of a "Particle Physics Project Prioritization Panel," dubbed simply "P5," in order to prioritize certain intermediate-term projects.

Listed among the top priorities in the report's roadmap is the Large Hadron Collider presently under construction at CERN in Switzerland and scheduled to become operational in 2006. The LHC is a circular machine that will smash protons into other protons at energies of 14 Tera-electron volts, seven times more powerful than the Fermilab Tevatron, which is currently the world's highest energy accelerator.

The report envisions a linear collider to be operational around 2012. There are at present several proposals for linear colliders being developed in different parts of the world, including a Japanese-Asian one, a German-European one, and an American one dubbed the Next Linear Collider.

"We give our highest recommendation to participation in such a machine, wherever it is built," said Barry Barish of Caltech, the other co-chair of the HEPAP long-range planning sub-panel that issued the report. "There is now a worldwide consensus on this priority."

As for what comes next, there are a variety of proposals for an assortment of new machines and new projects, including another proton-proton collider with energies an order of magnitude above that of the LHC.

"Beyond the LHC and the linear collider are other proposals, including a Very Large Hadron Collider (VLHC), a Muon Collider, a Neutrino Factory and a third generation linear collider called CLIC," said Bagger. "Our report strongly supports research and development toward these efforts as well. VLHC energies could be 100 to 200 Tera-electron volts, but we really don't know."

One project for which the draft report does not recommend immediate funding is the BTeV experiment at Fermilab, which is designed to probe for new quark physics at the electro-weak scale by studying "flavor changing processes" and probing for CP violation. With a price tag of $250 million and its funding not yet approved, the draft report states "we regret that we cannot recommend funding BTeV as a line item at this time."

Sheldon Stone of Syracuse University, one of the two lead scientists on the BTeV project, said he was told that HEPAP has no intention of killing the experiment and that the wording of the final report will show this.

"I was totally shocked by what they said, but then they said they didn't mean that," Stone said. "This is a draft and we shouldn't be discussing details until the final report comes out in January."

Bagger said that his panel left open the possibility for future BTeV funding.

"Our panel had some very carefully written words that we couldn't recommend that BTeV be funded in the very near future, but certainly the door would be open for funding down the line."

The five recommendations of the subpanel are that:

• The US undertake a broad program of research "focused on the frontiers of matter, energy, space, and time" that includes a commitment to sharing intellectual insights, providing highly scientifically and technologically trained individuals to the economy, and developing new technologies to improve society.

• The high-energy physics community follows the 20-year road map outlined in the report that prioritizes what facilities to build and projects to fund in a "balanced program to maximize scientific opportunity" and that includes creation of a panel that will update the roadmap as necessary.

• The US take the leadership through the DOE and the NSF and the involvement of the full particle physics community in building a "high-energy, high-luminosity, electron-positron linear collider."

• The US prepare a bid to host this linear collider, and that its site "take full advantage of the resources and infrastructure available at SLAC and Fermilab."

• There be "vigorous, long-term research and development aimed toward future high-energy accelerators" and "development of particle detectors and information technology" for international collaboration.

First Annual North Texas Grad Programs in Physics Workshop

Photo courtesy of William S. Bargett

Physics majors representing nine Zone13 SPS Chapters attend the 1st Annual North Texas Graduate Programs in Physics Workshop hosted by the University of Texas at Dallas on November 3. Students and faculty from Austin College, Baylor, Stephen F. Austin, University of Dallas, SMU, TCU, University of North Texas, UT-Arlington, and UT-Dallas heard oral presentations and viewed posters describing the educational and research opportunities offered by the Master and PhD physics programs at the participating institutions. In this photo, students are listening to the presentation by the UT-Dallas Chairman, Dr. Roderick Heelis. Further information about the Workshop can be found at http://www.utdallas.edu/dept/physics/NTGPP.htm.

SPOTLIGHT on the Profession of Physics

Physics Revitalization in a Decade of Transitions

By Philip W. Hammer

"Our challenges are reduced to a marketing problem."

—Philip W. Hammer

Over the past decade, the physics community has experienced plummeting degree production, evolution in the demand for physicists, increased salaries, and introspection about the state of physics education. All of this is the coupled to a bubble economy that is either bursting or bouncing. This state of affairs comes at a time of general prosperity in an increasingly technical economy. Yet department chairs are nervous because of the tenuous relationship between physics departments and students, particularly undergraduates.

The physics community needs to respond urgently to an historic shift in the role that physics plays in society. The situation calls for a community-wide assessment of how physics fits into modern society, followed by innovative reforms to physics education to bring students back and revitalize the field. The first step is to recognize that the department is the fundamental social unit of the physics community. As such, chairs and faculty should change their departments' approach to physics education in an attempt to keep up with the times. Many already have, and their innovations show promise in that they have grasped the essential nature of the changing world of physics. They have leveraged the economic advantages of physics to create new programs and recruiting strategies.

The labor economics of a physics degree is encouraging. At all degree levels, the supply of physicists is low compared to the supply of scientists from other technical fields, and in comparison to historical per capita numbers. Concurrently, demand for physicists is high as measured by relative employment rates and salaries. Thus, those with a degree in physics will be statistically competitive in our technical economy.

While the low supply of physicists may be great for individual physicists competing in the job market, the shrinking population of physics majors spells trouble for physics departments, many of which are seeing their degree programs threatened because of declining productivity. Why are students leaving physics?

My conjecture is that students perceive a disconnect between what they learn in physics and their immediate career goals. In addition, industry does not explicitly recognize the value and broad applicability of a physics degree. Furthermore, these perceptual barriers among students and employers are intertwined via negative feedback: employers express their hiring values through job ads; students respond in lockstep by populating engineering and computer science programs out of fear of unemployability; upcoming students see all the action occurring outside of physics and direct their attention accordingly. And all the while, employers continue to focus their efforts on the biggest reservoir of talent. In the midst of this dynamic, physics departments have done little to address and correct the misperceptions driving this system.

Our challenges are reduced to a marketing problem. As the fundamental social unit of the physics community, departments must take ownership of this problem, first by changing people's perception of physics using outreach strategies laced with facts and anecdotes and then by offering a product to students and employers that backs up these assertions with real value.

For example, demand for physicists is up and the diversity of this demand is becoming an asset valued by the community. Until the recent correction in the high tech sector, it had been a seller's labor market, and many physicists found lucrative and stimulating opportunities in fields far removed from academia. Physics is not a risky economic choice. This is a powerfully simple message to deliver to students. Furthermore, the strength and breadth of a physics degree creates an intellectually nimble employee who can retool in real time, enabling him or her to respond efficiently to new challenges.

Crafting a similarly compelling message for industry is trickier. There is no monolithic "industry," and every company will have its own personality, needs and culture. Therefore, marketing physics to employers requires developing personal relationships to understand the nature of particular companies' needs and creatively coupling them to your department's strengths and capabilities. I call this approach, "Take physics local," because crafting the message means connecting with those employers most likely to hire your students. Some digging will reveal former students in these companies, some of whom will be in positions to hire. Alumni will be familiar with the department and will have a sense of what physics has to offer.

Many departments are taking physics local and have begun to market themselves differently. They are crafting new programs that explicitly address the expectations of students and the needs of employers. One trend is the emergence of the Professional Masters Degree (PMD). PMDs emerged in the booming economy of the 1990s as a strategy to combat declining enrollments, capitalizing on a recognition of the fundamental strengths of a physics degree and the broad societal benefits of physics. Now that the economy is in another period of transition, individuals and institutions must be even more nimble than before, and they will have to be more aggressive in marketing their strengths.

PMD programs meet the needs of a well-defined sector of employers; they are multidisciplinary; they are non-thesis and time-limited; they operate in consultation with advisors representing the companies most likely to hire their graduates; and they emphasize workplace skills such as teamwork, project leadership, communication and interpersonal skills, as well as technical excellence. PMDs are alternatives to research-based graduate programs for those who desire further education to enhance their employability, and are also designed with the needs of future employers keenly in mind.

For physics departments, PMDs and other programmatic innovations could provide the type of fresh approach that attracts students and outside partners, such as employers, in a way that revitalizes the department. Such revitalization could provide the competitive edge that enables departments to thrive during difficult transitional periods, and positions them well for the next economic upswing. For individual physicists, current adjustment in the economy creates challenges. Yet those holding a physics degree and armed with a curious mind and flexible ambitions remain among the most competitive in the labor force because of their education and inherent adaptability. Physicists nearing the end of their undergraduate years will have many choices to make. I am encouraged by the growth in PMDs because they offer revitalizing optimism for physics departments, and they provide viable options for the physics-talented who seek non-research, economically viable alternatives to the PhD.

The economic ride we are on promises many surprises. Those institutions and individuals best prepared will fare best in competitive times of uncertainty. Physics has shown itself to be an excellent career accelerator in good times, and a good shock absorber in more difficult times. I am confident that physics will remain an excellent choice for students, and that innovative departments will emerge strengthened by this decade of transition.

Philip W. Hammer is at the Franklin Institute Science Museum in Philadelphia, Pennsylvania.

Hadronic, *from page 1*

drive hadronic physics. From a funding standpoint, "It is difficult to argue for funds for a field which is regarded as voiceless or even nonexistent," says Swanson, adding that both DOE and NSF representatives "have told us bluntly to organize and build a coherent presence."

The move to form a topical group began in October 2000, when Swanson and his co-founders realized that "there was a pent-up need for representation," and decided an APS topical group was the least disruptive means of achieving these goals. Since then more than 330 physicists from 34 countries around the world have signed the petition to form such a body. The only country with an official hadronic physics organization is Germany, and hence the organizers expect the new APS topical group to bring in many new international members, as well as creating a home for several hundred American hadronic physicists and providing vital advocacy with funding agencies.

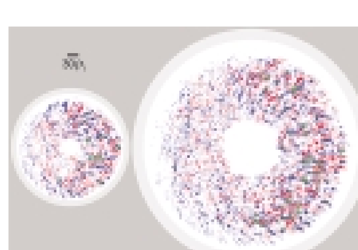
While some express concern that adding yet another unit to the APS structure will further balkanize the Society, Swanson believes that careful organization can prevent such an effect. The leadership of the new topical group and that of the APS Division of Nuclear Physics have agreed to work together in promoting the interests of both groups.

For example, the topical group program committee could make suggestions for a hadronic component to DNP meetings, which would increase attendance of hadronic physicists at such meetings and generate new interdisciplinary contacts.

"I am impressed by the list of people who signed up," says DNP Chair Joel Moss of Los Alamos National Laboratory. "The group may well achieve the goal of bringing more attendance and participation to the April meeting." As for collaboration with other units, there is already a joint DNP/DPF session on hadron spectroscopy planned for the April 2002 meeting in Albuquerque.

DPP Meeting, *from page 1*

Supercomputer Provides Encouraging News for Commercial-Scale Fusion Reactors



Princeton Plasma Physics Lab

Massively parallel simulations at the world's fastest unclassified supercomputer provide realistic assessments of plasma turbulence in large-scale fusion reactors.

Using the new IBM SP, the world's fastest non-classified supercomputer, located at the National Energy Research Scientific Computing Center (NERSC) at California's Lawrence Berkeley National Laboratory, researchers have discovered that future large-scale fusion reactors may be able to trap or "confine" hot plasma fuel more efficiently than previously projected. The deleterious effects of heat loss resulting from the turbulence within the plasma seem to be reduced as one scales up from present-day experimental devices to a bigger, commercial-reactor-scale machine. Better confinement means that it would be cheaper to operate such a reactor, since less energy would have to be expended to maintain the requisite high plasma temperatures. Alternately, better confinement could enable researchers to build a somewhat smaller fusion device to achieve the same conditions envisioned for a large-scale machine.

The new simulations explore some of the key consequences of scaling up from present-day experimental devices to those of reactor dimensions.

Promising Inertial Fusion Tests at OMEGA

Frozen fusion fuel pellets tested at the University of Rochester's OMEGA laser facility have performed exceptionally well in experiments that will help lay the foundation for future inertial confinement fusion (ICF) research. The pellets are tiny spherical shells less than a millimeter in diameter containing an inner layer of frozen deuterium, which serves as fuel in ICF experiments. To ignite ICF reactions, numerous laser beams directed at a pellet's surface vaporize the shell, compressing and heating the deuterium to the extreme conditions necessary for fusion to begin.

Photonic Crystal Produces Powerful High-Frequency Microwaves

Using metal rods arranged in a specific geometric pattern, MIT physicists have designed a gyrotron, a device that generates powerful microwaves at very high frequencies. Such microwaves could provide more effective long-range telecommunications and improve microwave cooking, since higher-frequency ovens on airplanes could more rapidly prepare food.

The metal cavity in the new device is formed of a "photonic band gap" (PBG) structure consisting of 102 metal rods geometrically arranged in such a way that it lets some microwave frequencies pass through the cavity while a particular frequency is trapped inside. The PBG structure helps in building larger cavities without generating microwaves at unwanted frequencies. In the gyrotron, the PBG structure keeps microwaves trapped at a particular frequency, which builds up their strength just as in a laser. The researchers generated 140 gigahertz (GHz) microwaves peaking at 25 kilowatts of power.

—Ben Stein and James Riordon, AIP Public Information

ANNOUNCEMENTS

Proposed Amendment to APS Bylaws Regarding an Elected Member of the Forum on Physics and Society on POPA

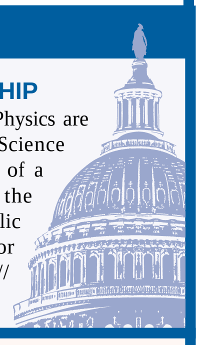
First Vote APPROVED By Council
November 18, 2001

The APS Constitution and Bylaws Committee has reviewed this proposed amendment and recommends its approval by Council. The Forum on Physics initiated the amendment and Society and it was subsequently approved by POPA.

The amendment, if approved by Council, would allow the Forum on Physics and Society to elect one person to serve as a member of POPA for a three-year term. It also reduces the number of Council-elected members to 14, with 4 members elected every third year rather than 5. This amendment will formalize the natural common interest between POPA and the Forum on Physics and Society. Similar relationships exist between the Committee on International Scientific Affairs (CISA) and the Forum on International Physics, and the Committee on Education (COE) and the Forum on Education.

Article III.B.1 *Panel on Public Affairs*.—The membership of the Panel on Public Affairs (POPA) shall consist of a Chairperson, Chairperson-Elect, Vice-Chairperson, immediate Past Chairperson, the Vice President, the Chair of the Physics Policy Committee, the Congressional Fellow(s) in the second year following the year of service, and ~~**fifteen**~~ **[fourteen]** members elected by Council to staggered three-year terms. **[In addition, the Forum on Physics and Society shall elect one person every three years to serve on POPA for a three-year term].** The Vice-Chairperson shall be elected by Council and shall serve in that office for one year, then as Chairperson-Elect for one year, then as Chairperson for one year, and then as most recent Past-Chairperson for one year. There shall be a Steering Committee consisting of the Chairperson, the Chairperson-Elect, the Vice-Chairperson, the Vice-President, the Chair of the Physics Policy Committee, and two members of the Panel elected from among and by the members of the Panel. The Panel on Public Affairs shall be responsible for making recommendations to the President, the Executive Board and the Council on public affairs activities of the Society designated by the Executive Board or Council. The Steering Committee may investigate new public affairs activities for the Society and may recommend new programs to the Council. POPA and its Steering Committee shall keep minutes and distribute them to the members of the Panel and to the Council.

FELLOWSHIP PROGRAMS



APS/AIP CONGRESSIONAL SCIENCE FELLOWSHIP

The American Physical Society and the American Institute of Physics are accepting applications for their 2002-2003 Congressional Science Fellowship programs. Fellows serve one year on the staff of a Member of Congress or congressional committee, learning the legislative process while lending scientific expertise to public policy issues. Application deadline is January 15, 2002. For more information, visit: http://www.aip.org/pubinfo or http://www.aps.org/public_affairs/fellow/index.shtml

APS Mass Media Fellowship Program

Applications are now being accepted for the 2002 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. Information on application requirements can be found at **http://www.aps.org/public_affairs/Media.html**.

DEADLINE: JANUARY 18, 2002

Prize & Award Nominations *http://www.aps.org/praw/*

Otto LaPorte Award — *DEADLINE: 01/18/02*
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.

Fluid Dynamics Prize — *DEADLINE: 01/18/02*
Supported by friends of the Division of Fluid Dynamics and the AIP journal Physics of Fluids. Purpose: To recognize and encourage outstanding achievement in fluid dynamics research.

Nicholas Metropolis Award for Outstanding Doctoral Thesis Work in Computational Physics — *DEADLINE: 01/31/02*
Establishment and Support: The award is supported by the Journal of Computational Physics, a publication of Academic Press. Purpose: To recognize doctoral thesis research of outstanding quality and achievement in computational physics.

Fusion Energy Science Fellowship Program

Sponsored by Office of Fusion Energy Sciences, US Department of Energy

BENEFITS INCLUDE: Full Payment of tuition and fees; Monthly stipend of $1,500; Summer research assignments at an approved FES Fellowship fusion facility; Appointment tenure up to three years; Limited travel funding to present papers at national or international conferences

APPLICANTS MUST: Be a US Citizen or Permanent Resident Alien; Be a BS recipient, undergraduate senior, or have not completed more than one full-time semester/quarter of graduate studies at the application deadline; Be planning full-time, uninterrupted study toward a PhD degree at an FES Fellowship Participating University

APPLICATION DEADLINE: January 28, 2002

CONTACT: Tom Richmond or Debbie Alcorn, MS 36; Oak Ridge Institute for Science and Education; PO Box 117; Oak Ridge, Tennessee 37831-0117; (865) 576-2194 or (865) 576-3428 or alcornd@orau.gov

Application information can be accessed at
http://www.orau.gov/orise/edu/uggrad/fesfelhome.htm

APS Council and Committee Position Nominations

VICE-PRESIDENT; GENERAL COUNCILLOR (2); NOMINATING COMMITTEE; Vice-Chairperson-Elect • Members; PANEL ON PUBLIC AFFAIRS; Vice-Chairperson-Elect • Members

Please send your nominations to: American Physical Society; One Physics Ellipse; College Park, MD 20740-3844; Attn: Ken Cole; (301) 209-3288; fax: (301) 209-0865; email: cole@aps.org. A nomination form is available at **http://www.aps.org/exec/nomform.html**.

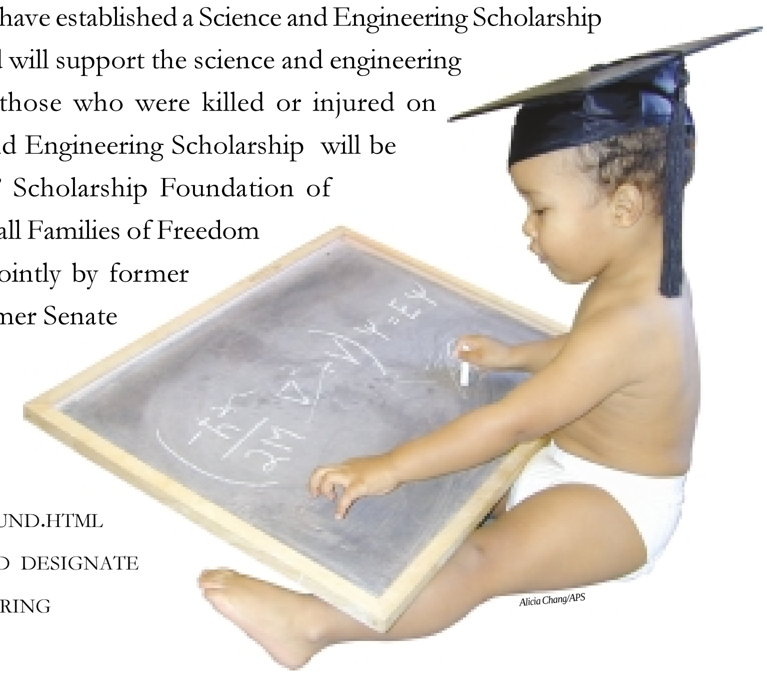
DEADLINE: JANUARY 31, 2002

SEPTEMBER 11TH

The Science and Engineering Community Can Make a Difference.

Donate Today to the Science and Engineering Scholarship Fund

In response to the tragedy of September 11, dozens of organizations representing more than a million scientists and engineers have established a Science and Engineering Scholarship Fund.* Donations to the Fund will support the science and engineering education of dependents of those who were killed or injured on September 11. The Science and Engineering Scholarship will be administered by the Citizens' Scholarship Foundation of America®. It is part of an overall Families of Freedom Scholarship Fund™ chaired jointly by former President Bill Clinton and former Senate Majority Leader Bob Dole.



Alicia Chang/APS

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Galileo and Perspective: The Art of Renaissance Science

By Joseph W. Dauben

Among the great figures of the Western scientific revolution of the 16th and 17th centuries—Copernicus, Kepler, Galileo, Descartes, Newton, Leibniz—all had at least one thing in common: they were all mathematicians. And yet, two stand out as being conspicuously different, for only Galileo and Newton were experimentalists. It was Galileo, at the beginning of the Scientific Revolution early in the 17th century, who demonstrated the extraordinary effectiveness of experimental observation of nature, coupled with the analytical power of mathematics.

Galileo's early work seems to have concentrated upon arguments against Aristotle, involving a sustained pattern of observation and demonstration requiring little in the way of mathematics, concentrating instead on physical experience. His most revolutionary observational discoveries came with the telescope, and these provided, for the first time, about 1610, a number of good physical arguments in favor of the Copernican theory. Later, Galileo's impressive discovery of the parabolic nature of projectile motion—elaborated fully in 1638—seemed to display the essentially mathematical character of physical phenomena. Galileo believed that nature was inherently mathematical, that mathematics was the language of nature, and that mathematics was the key to understanding the reality behind the appearance of natural phenomena—for example, accelerated and parabolic motions.

What Galileo achieved in revolutionizing physics was to show how observation, careful measurement, and attention to the structure of a given event all led to an appreciation of hidden causes that ultimately expressed the pervasive mathematical unity of all nature. Yet he was not the first to have done this, although in terms of astronomy and physics he was clearly a pioneer. Renaissance artists—painters, sculptors and architects—had been observing nature with a special interest in depicting it realistically from the early 15th century on. In fact, by turning to the problem of art and science in the Renaissance, it is possible to find what I believe are important roots for Galileo's own peculiarly realistic—and idealistic—approach to nature. For the values and attitudes Galileo held were ones he shared with Italian humanists, including philosophers, artisans, even musicians.

The first steps towards a new sense of artistic reality were taken early in the 15th century. One of the earliest masters of the human form was Masaccio. In his "Expulsion from Paradise," painted about 1427 in Florence, one can easily see the results of careful observation of human anatomy. Masaccio's Adam reflects the underlying structure of skeletal frame and superimposed muscle, as does his fresco of "Peter Baptizing the Neophytes." A century later, art and anatomy combined dramatically in the studies of Andreas Vesalius, the Flemish physician whose major work, *On the Structure of the Human Body*, was illustrated by one of Titian's students. The illustrations provide a graphic, detailed record of the musculature and skeletal framework of the human body, and literally seem to pare away layer upon layer of muscle to reveal the hidden structure underneath.

> "Galileo, like Renaissance artists of the 15th century, was interested in form, in the underlying reality of the natural world."

The first artist to perform actual dissections to improve his anatomical knowledge may well have been Antonio Pollaiuolo. His painting of the "Martyrdom of St. Sebastian," his last work completed in 1475, is a tribute to his virtuosity. In much the same way, Luca Signorelli undertook to complete a series of frescoes in Orvieto between 1499 and 1504. In both "The Damned Consigned to Hell" and in the "Resurrection of the Dead," Signorelli seems to have adopted unnatural and contrived positions for many of his figures, again to show his skill in representing the human body.

The ultimate achievement of this sort, however, was brought to perfection by Michelangelo, whose mighty Adam in the Sistine Chapel seems a direct evolution, artistically, from the Signorelli in Orvieto. In fact, we know that artists of the late 15th century like Michelangelo and Leonardo actively pursued anatomical dissections to perfect their understanding of the human form.

In the same year that Galileo's *Dialogue Concerning the Two Chief World Systems* was published in 1632, Rembrandt painted his famous "Anatomical Lecture", graphically representing what physicians had learned from Renaissance artists: that nature was accurately representable only by virtue of careful observation, through anatomical dissection revealing the hidden structure underlying the human form.

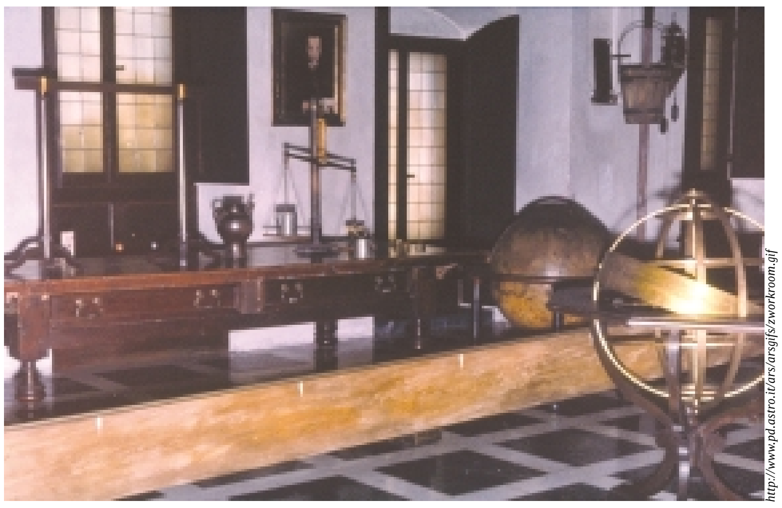
What Renaissance artists had clearly achieved through careful observation of nature, including studies of anatomical dissections, was a means to recreate the 3-dimensional physical reality of the human form on 2-dimensional surfaces. In part, the key to this achievement lay in understanding the underlying, hidden structure of the human body which then enabled the artist to produce realistic representations of what he saw on the flat surface of a wall in the case of frescoes, or on a wooden panel or paper in the case of drawings.

If artists in the 15th century had learned to portray with faithful accuracy the human body through careful observation and anatomical dissection—a similar inspiration occurred to those seeking a corresponding dramatic reality in the representation of physical space. A means was devised early in the 15th century for translating the reality of 3-dimensional natural phenomena onto 2-dimensional surfaces, producing virtually realistic copies. A correspondence was thus made possible, through mathematics, between the representational reality of the artist and the physical reality of nature.

The first to carry out a series of optical experiments that led to a mathematical theory of perspective was the Florentine architect and engineer Filippo Brunelleschi. His most stunning accomplishment, in fact, is the stupendous dome which crowns the cathedral in Florence, a work which occupied him intermittently from 1417 to 1434. The technical difficulties involved in erecting the new dome underscore an important aspect of his talents: he was a daring innovator, with a solid knowledge of mathematics and mechanics.

Mathematics was equally important to Renaissance artists in determining the correct proportions for the figures they drew. Leonardo da Vinci followed such principles explicitly, measuring not only the proper proportions of the human head, but the dimensions of the various parts of the anatomy of the horse as well. This was all embodied literally in his most complete visual statement of the harmony between mathematics and nature, his famous drawing of the human figure, proportioned in keeping with the architectural perfection of the square and circle.

It is no coincidence, I think, that the artistic Renaissance and the scientific Renaissance should have both developed at first largely in Italy. Scientists like Galileo were doing exactly what Renaissance artists had been doing all along, with growing skill and increasingly sophisticated techniques, in their depictions of nature in realistic terms since the late 15th century. The veracity of



http://www.pd.astro.it/ars/arsgifs/zworkroom.gif

A replica of Galileo's workroom, as recreated at the Deutsches Museum in Munich, Germany.

their mathematical vision was well-established by the time Galileo began thinking about the mathematics—the geometry—of space nearly a century later. What Renaissance artists had discovered was that in addition to careful observation and attention to underlying physical structure—often this meant anatomical structure—mathematics was an especially useful tool for translating the physical reality of 3-dimensional objects in 3-dimensional space into realistic illusions of that same reality on only 2- dimensional, flat surfaces.

Galileo, like Renaissance artists of the 15th century, was interested in form, in the underlying reality of the natural world. He, too, was interested in the sort of physical reality that he felt his mathematics and the telescope were making clear for the first time. Light, optics, mathematics—all were as important keys for Galileo as they had been for Brunelleschi, Alberti and Piero della Francesca. From Plato Galileo took his faith in the ultimate rationality of nature, and the fact that the key to understanding nature was to be found in the ideal, perfect world of mathematics; but from Aristotle Galileo also understood that to understand nature, one must also be a systematic observer, and that it is only through experience and careful study of nature that the hidden secrets—the mathematical structures underlying the appearance of physical events and phenomena—can be discovered.

Galileo achieved a synthesis of observation and theory in a way that was strikingly modern and yet was also a product of the centuries of Italian humanism and the tremendous burst of energy we associate with the artistic Renaissance. New discoveries advanced the arts as well as the sciences, and many of these were due to new instruments and methods, especially ones related to mathematics.

Renaissance artists had contributed greatly to man's knowledge by the time Galileo was doing his first work at Pisa. The humanist artists of the Italian Renaissance had performed their own dissections to promote the study of anatomy, they had invented mathematical perspective to make possible the accurate, realistic portrayal of physical space. The literary humanists had managed to revive all sorts of classics, in particular the works of Plato. Christopher Columbus had directly challenged the limits to the finite European world of Ptolemy's geography. The bounds of human knowledge were expanding at a rapid rate. Renaissance artists were seeking a new world, thanks in part to mathematics and the new perspective, literally, that mathematics provided.

Renaissance artists and architects had already succeeded in translating physical space into the mathematical terms of proportion and perspective to produce works that tricked the eye and rivaled nature. Galileo used mathematics with equal skill to reveal the underlying structure of physical space and motion to show that these, too, could be reduced to mathematical analysis. In connecting physical space and real motion—which could be observed experimentally—with the ideal and uniform change of his neo-platonic, mathematical world, Galileo also served to bridge the early stages of the scientific revolution in Europe—featuring figures like Copernicus and Kepler—with the later unifying achievements of Descartes, Newton and Leibniz.

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Copies of "The Art of Renaissance Science," a videotaped presentation of this material produced by Science Television, are available from the American Mathematical Society and through Amazon.com.