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NMD Study Group Tackles Boost-Phase Systems

The debate over ballistic missile defense has made national headlines in recent months, with the Bush administration favoring expansion of the national missile defense (NMD) program to include weapons to attack missiles during their boost phase. As first reported in this year's January *APS News* (http://www.aps.org/apsnews/0101/010103.html) the APS is seeking to help inform the debate by sponsoring an independent study to explore the technical feasibility of such boost-phase intercept (BPI) weapons. Chaired by Daniel Kleppner (Massachusetts Institute of Technology) and Frederick Lamb (University of Illinois), the study group is now examining several key technical issues and will prepare a report entitled, "The Science and Technology of Boost Phase Systems for National Missile Defense." The study has financial support from both the MacArthur Foundation and the W. Alton Jones Foundation.

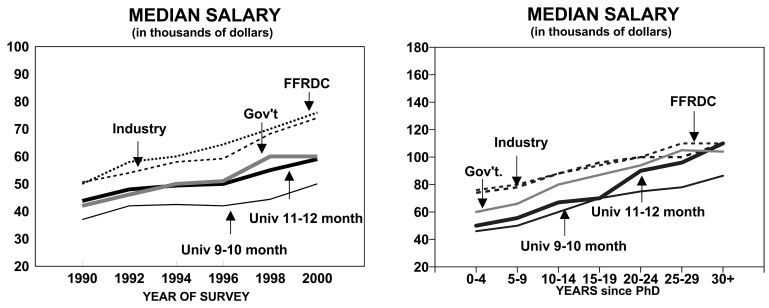
The APS has extensive experience conducting thorough, rigorous and objective technical studies of technologies and systems with major policy implications, most notably the directed energy weapons (DEW) study conducted in 1985-1986 that made national headlines when its findings were released. The idea for an APS study of NMD arose in the APS Panel on Public Affairs (POPA), and in August 2000 then APS President James Langer

See NMD STUDY *on page 3*

Physics Salaries on the Rise

Physicists, especially those employed in industry, continued to enjoy rising salaries in 2000, according to results from a recent survey conducted by the American Institute of Physics (AIP) Statistical Research Center. The median annual salary for full-time employed respondents with PhDs reached $78,000, while those with master's degrees earned a median salary of $63,000, and those with bachelors degrees, $60,000. And AIP society members who received their PhDs within the last five years, and are not postdocs, report median salaries that are 9% higher than their colleagues with similar experience in 1998. (The AIP consists of 10 member societies, of which APS is the largest.)

The AIP study is the latest in a series produced biennially since 1979 to monitor the effects of demographic factors on salary levels, based upon data reported by the US members of AIP's member societies. More than one-sixth of the non-student US resident members of AIP member societies were randomly selected for the latest survey, with over 15,000 questionnaires mailed out in May, requesting information on demographics, educational attainment and employment. Of these, nearly 9,350 were completed and returned, for a 62% response rate.



[FFRDC = Federally Funded Research and Development Centers]

According to Raymond Chu, one of the report's co-authors, several factors influence the wide range of salaries reported by scientists: degree level, experience, and the employment sector and geographical region of employment. Of these, degree level has the most impact on salary. "The higher the level of education attained, the higher the salary earned," he says. Median

See SALARIES *on page 8*

New Grad Student Executive Committee Meets

Alicia Chang/APS

The new Forum in Graduate Student Affairs held its first Executive Committee meeting at APS headquarters in July. Committee members are: Jennifer West, Louise Parsons, Chad Topaz, Joshua Patin, Susan Niebur, Hsuan-Yeh Chang, Greg Recine and Xin Chen.

BREAKING NEWS!

APS Gets Major NSF Funding for Education

As *APS News* was going to press, it was learned that the APS, together with its partners the American Association of Physics Teachers and the American Institute of Physics, had just received full funding of a National Science Foundation grant for the Physics Teacher Education Coalition (PhysTEC) to improve the science preparation of future teachers.

The award totals $5,765,151 over five years. Full details on the grant and the PhysTEC program will appear in next month's *APS News.*

Bachelors Decline Continues, But Turnaround Expected

By Richard M. Todaro

The number of people receiving physics bachelor's degrees continued to drop in 1999, reaching a 40-year low, and the number of people receiving physics PhD degrees slid in 1999, marking the fifth consecutive decline, according to a just-released report from the American Institute of Physics.

But the report notes that the number of undergraduate students in their junior year who were enrolled in physics programs in 1999-2000 rose four percent over the previous year.

"In the near future, I expect an increase in the number of physics bachelor's degrees," said Patrick Mulvey, a technical research associate with the American Institute of Physics and lead author of the report. "I look to see if that number is rising or falling. I use that as a method to anticipate whether the number of degrees are going to be doing in a year or two."

Mulvey also said that an upturn in such undergraduate physics program enrollment will likely eventually translate into an increase in the number of physics PhD degrees.

"The majority of people who go on to get a PhD in physics have a bachelor's of science in physics. Almost half of all people with bachelor's physics degrees continue with graduate school. This is not true of other fields."

Other significant findings in the report include the growing representation of women receiving physics bachelor's degrees, and the continued significant under-representation of Hispanics and African Americans among physics degree recipients at both the undergraduate and graduate levels.

In a fall 1999 survey of 762 degree-granting physics departments across the United States, Mulvey and co-author Starr Nicholson found that 3,646 physics bachelor's of science degrees were conferred in the class of 1999. This represents a decline of 175 degrees or about five percent over the class of 1998 and a drop of 1,304 degrees or 26 percent over the class of 1991.

The vast majority of these degrees or about 93 percent of the total—were awarded to US citizens, since foreign students as a rule generally do not study physics at the undergraduate level in the United States.

Women earned 21 percent of the physics bachelor's degrees conferred in 1999, a new high and up 3 percent over the 1998 number. Back in 1978, women accounted for just 9 percent of the total receiving bachelor degrees in physics.

See BACHELORS *on page 7*

Physics Olympians Bring Home 3 Gold, 2 Silver

Five high school students, representing the US at the International Physics Olympiad (IPO), brought home an impressive victory in July: three gold and two silver medals. The team also finished third overall in the competition, just behind students from China and Russia.

Brian Beck of Ohio (gold medal), Vladimir Novakovski of Virginia (silver medal), Willie Wong (gold medal) and Daniel Peng (silver medal), both of New Jersey, and Andrew Lutomirski of California (gold medal), were selected from an original pool of more than eleven-hundred students from across the country to travel to Antalya, Turkey as part of the US Physics Olympiad Team to the IPO.

The international competition included a

See STUDENTS *on page 3*

Courtesy of Leif Turner, Senior Coach of the 2001 US Physics Team

Physics Olympians from left to right are: Willie Wong, Vladimir Novakovski, Brian Beck, Andrew Lutomirski, Daniel Peng

HIGHLIGHTS

"Members in the Media"

On the launch of the MAP satellite to measure anisotropy in the cosmic microwave background, *CNN Headline News*, June 30, 2001:

"These patterns in the light hold the keys for understanding the history, content, shape and ultimate fate of the universe"
—Charles Bennett, NASA

"The most important thing MAP will tell us is: are we on the right track on our theories about the early universe."
—David Wilkinson, Princeton University

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"Once we acknowledge the possibility that empty space can have energy, our ability to unambiguously predict the future of the universe goes out the window."
—Lawrence Krauss, Case Western Reserve University, Dallas Morning News, July 2, 2001

"Generally speaking, these things just don't happen."
—John Marburger, Director of Brookhaven National Laboratory and President Bush's choice for science advisor, on whether the Relativistic Heavy Ion Collider at Brookhaven could produce a black hole that would endanger Earth, Washington Post, July 2, 2001

"As an advisor to the president he is absolutely perfect, I just am in awe of what he's been able to do with this laboratory."
—Robert McGrath, SUNY Stony Brook, on Marburger's nomination for science advisor and his performance at Brookhaven, New York Times, July 3, 2001

"I'm here so that I can [persuade] particle physicists that there's a lot of particle physics to be done by looking at the [cosmic] microwave background."
—Suzanne Staggs, Princeton University, on why she was attending the Snowmass meeting on the future of particle physics, Los Angeles Times, July 9, 2001

"After 37 years of searching for further examples of CP violation, physicists now know that there are at least two kinds of subatomic particles that exhibit this puzzling phenomenon."
—Stewart Smith, Princeton University, on evidence from SLAC that there is CP violation in the B-meson system, BBC News Online, July 9, 2001

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Comments from Snowmass on why the next big accelerator needs to be international, *New York Times*, July 10, 2001:

"...what we're looking at is a way for the international high-energy-physics community to come together and develop its own plan."
—S. Peter Rosen, Department of Energy

"It is forced on us by the richness of our science and the cost of our science."
—Jonathan Dorfan, Stanford Linear Accelerator Center

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"We're doing what we were doing before that hint came up. Our goals do not fluctuate with those statistics."
—Michael Witherell, Director of Fermilab, on news that CERN's possible evidence for the Higgs boson seemed to have gone away, New York Times, July 11, 2001

"The current patent really is the blueprint for the research we're going to be doing for the next four years."
—Stan Williams, Hewlett Packard, on a breakthrough in molecular switching, New York Times, July 17, 2001

"Nowhere else will the disciplines of chemistry, physics, biology, computer science and enormous amounts of equipment be brought together."
—Philip Kuekes, Hewlett Packard, on the establishment of the California Nanoscience Institute by the University of California, Los Angeles Times, August 13, 2001

"That's enough events to begin a study using statistical techniques."
—Adam Rusek, Brookhaven National Laboratory, on the production of 40 doubly-strange nuclei, Physicsweb, August 15, 2001.

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And finally, two quotes on recent astrophysical evidence that the fine structure constant may be increasing with time:

"The effect does not scream at you from the data. You have to get down on all fours and claw through the details to see such a small effect."
—John Bahcall, Institute for Advanced Study, New York Times, August 15, 2001

"The data contain clear indication that these constants were slightly different in the distant past. We have performed numerous sophisticated tests, and the data passed all these tests."
—Victor Flambaum, University of New South Wales, Washington Post, August 20, 2001

This Month in Physics History

October 1871: Babbage's Successful Failure—The First Computer

Few 19th century devices have had as much influence on modern technology as Charles Babbage's calculating engines, most notably the Analytical Engine, a mechanical digital computer which anticipated virtually every aspect of present-day computers. First described in 1837, his vision of a massive brass, steam-powered, general-purpose mechanical computer inspired some of the greatest minds of the 19th century, but he failed to persuade any backer to provide funds to actually construct the device. However, his ingenuity earned him recognition as the "father of computing" more than 100 years after his death.

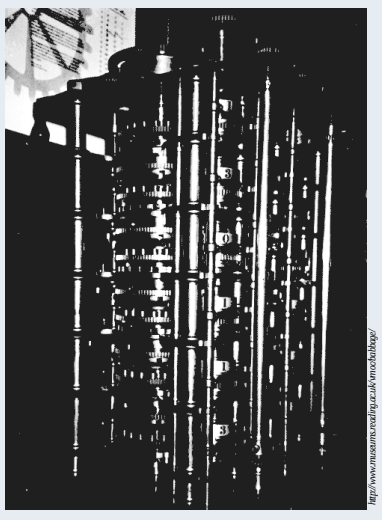
The son of a London banker, Babbage was a tinkerer from birth, doing little else with his toys save dissecting them. He taught himself algebra as a youth, and was so well read in the continental mathematics of his day that when he entered Trinity College, Cambridge, in 1811, he found himself far in advance of his tutors in the subject. With friends, Babbage co-founded the Analytical Society for promoting continental mathematics, and reforming the math of Newton currently taught at Cambridge. Most notably, he and his friends effected the crucial introduction of the Leibnitz notation in calculus, transforming mathematics throughout Great Britain.

As a young man, Babbage worked as a mathematician, was duly elected a Fellow of the Royal Society, and played a prominent role in the foundation of the Astronomical Society (later the Royal Astronomical Society) in 1820. Around the same time, he developed his lifelong interest in calculating machinery. In 1821, Babbage invented the concept of the Difference Engine to compile mathematical tables. The Difference Engine Number One (DE1) was the first successful automatic calculator and remains one of the finest examples of precision engineering of the 19th century. It created tables of values by finding the common difference between terms in a sequence, limited only by the number of digits the machine had available. Babbage's idea was that astronomical tables could be printed out using such a machine, as well as simple lists of prices for a butcher's shop that charged by the pound.

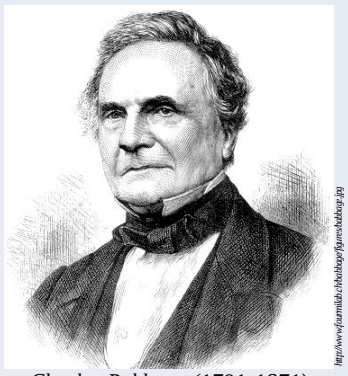
Although he refined this concept with the Difference Engine Number Two (DE2), Babbage was never satisfied with his work and could never stick with a single blueprint for it. He spent thousands of pounds of government funding to rebuild the same parts over and over to refine them. Never actually completed or used, the Difference Engine's main contribution to the world ended up being the ideas it inspired in Babbage's mind, leading to his next engine, and ultimately to modern computer programming.

In 1832 he conceived of an even better machine that could perform not just one mathematical task, but any kind of calculation. Intended as a general symbol manipulator, the Analytical Engine was a flexible and powerful punched-card-controlled calculator, embodying many features which later reappeared in the modern stored-program computer: punched-card control, separate store and mill, a set of internal registers (the table axes), fast multiplier/divider, and even array processing. He resigned his prestigious professorship at Cambridge [the Lucasian chair once occupied by Sir Isaac Newton] in 1839 to devote his full attention to the analytical engine, but never succeeded in completing any of several designs for it.

Unfortunately, little remains of Babbage's prototype computing machines. The critical tolerances required exceeded the level of technology available at the time. And although his work was formally recognized by respected scientific institutions, the British government suspended funding for the Difference Engine in 1832, ending the project completely in 1842.



The Difference Engine designed by Charles Babbage (1792-1871) in the Science Museum, London.



Charles Babbage (1791-1871)

Despite his many achievements, the failure to construct his calculating machines, and the failure of the government to support his work, left Babbage in his declining years a disappointed and embittered man. He died on October 18, 1871, without ever realizing his dream, and although his son Henry continued his work, he never successfully completed the device. It was only after the first electromechanical—and later, electronic—computers had been built in the 20th century that designers of those machines discovered the extent to which Babbage had anticipated almost every aspect of their work.

Babbage's difficulties were primarily financial and organizational; the project itself was perfectly feasible. A team at London's Science Museum—led by Doron Swade with important contributions from D. Allan Bromley, among others—successfully built a completed version of Babbage's DE2 in the 1990s, vindicating the man's technical work, which is now prominently displayed in the museum. However, the far more ambitious task of constructing the Analytical Engine remains to be undertaken.

Further Reading:

Charles Babbage Institute: http://www.cbi.umn.edu

Bromley, Allan, "The Evolution of Babbage's Calculating Engines," *Annals of the History of Computing*, 9 (1987): 113-136.

Hyman, Anthony. *Charles Babbage, Pioneer of the Computer*, Oxford University Press (1982).

Hyman, Anthony. *Science and Reform: Selected Works of Charles Babbage*, Cambridge University Press (1982).

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Editor ..... Alan Chodos
Associate Editor ..... Jennifer Ouellette
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Booth Carries APS Message to Physics Teachers

Photo courtesy of Mona Miller

APS Public Outreach Specialist Jessica Clark (far left) discusses Physics Central with a passerby while PR Focus Editor David Ehrenstein holds an onlooker spellbound with his juggling skills at last summer's meeting of the American Association of Physics Teachers.

Russia Lifts Restrictions but Persecutions Continue

By Richard M. Todaro

Recent critical media attention and pressure from scientific organizations abroad have prompted the Russian Academy of Sciences to back off a controversial directive issued in May requiring all its researchers to report all contacts with foreign scientists.

The academy's governing presidium decided on June 19th to rescind the order and replace it with a much less sweeping one dealing only with "secret" programs, but that decision was not made public until July.

Nevertheless, critics contend that the Russian government is persecuting increasing numbers of scientists and environmental activists by using arbitrary definitions of what constitutes a state secret. They point to a number of cases in which treason charges were leveled against individuals who have been detained for months while awaiting trial.

As reported in the June 8, 2001 *Science*, the initial Russian Academy of Sciences directive required "constant control" over all aspects of cooperation between Russian scientists and their foreign colleagues. All 55,000 researchers at all 357 academy institutes were required to file detailed reports on any international activities, including sending articles abroad for publication, applying for

See PERSECUTIONS *on page 6*

Students, *from page 1*

five-hour long laboratory test, as well as a five-hour long theoretical test. The team competed against 300 students from more than 60 countries for their medals. "We are so excited for the students," says Dr. Bernard Khoury, Executive Officer of the American Association of Physics Teachers, which co-sponsors the team with the American Institute of Physics. "They have worked so hard; to see them achieve this is incredibly rewarding."

The US Olympians do not limit their interests to science and mathematics. Beck is active in debate and journalism, as well as competing in golf and tennis. Lutomirski studies Russian and is active in the local Anti-Defamation League, also pursuing interests in theater lighting, ceramics and fencing. Wong plays saxophone in his high school band and is an avid bridge player. Peng is on the chess team, skis and scuba dives, and is active in the Junior State of America, a political awareness and debate organization dedicated to making young Americans aware of critical national policy issues.

Now in its 15th year, the US Physics Olympiad program was started in 1986 with the mission of promoting and demonstrating academic excellence, by fielding a team to compete against other nations in the International Physics Olympiad.

NMD Study, *from page 1*

appointed a special advisory committee, chaired by Lamb, to consider whether the Society should undertake such a study. After reviewing current and proposed missile defense programs and technologies, the committee recommended that the APS conduct a study of BPI technologies and systems. The APS Council accepted the committee's recommendation in November 2000.

"Many of the key questions concerning the technical feasibility of the BPI systems that have been proposed can be addressed by considering basic physical principles," says Lamb, and Congress has expressed interest in information on the technical challenges involved in developing an effective BPI system. Thus, "an independent technical analysis of BPI technologies and systems by a group of physicists and other technical experts could increase significantly the nation's understanding of the issues involved, and impact upcoming decisions concerning NMD."

In addition to Kleppner and Lamb, eleven others are serving as members of the study group, bringing various areas of expertise to the study. The group is conducting an in-depth, unclassified technical review of proposed boost-phase intercept technologies and will estimate the characteristics of the BPI systems that would be required to accomplish various proposed NMD missions. The study is expected to examine the use of radars and infrared sensors to provide missile tracking information; the required sizes and weights of land-, sea- and space-based interceptors; the technical challenges involved in using airborne lasers to intercept long-range missiles; the warning and response times that would be required for a BPI system to be effective; and other technical questions.

The study group's report will also summarize the most important and challenging unresolved technical issues involved in mid-course intercept that have been identified by other studies. However, it will not address the arms control or strategic stability implications of developing and deploying NMD systems. "These implications are very important, but to address them meaningfully and credibly would require a longer study, a larger group, and a wider range of expertise," says Kleppner.

The group met for the first time in July in Chelsea, Massachusetts, for a four-day session, and is holding a series of further meetings through January 2002. The goal, says Kleppner, is to complete the final report by the end of February 2002. While not at liberty to discuss details of the group's activities until the report's release, both he and Lamb say they are pleased at the progress made thus far.

NMD STUDY GROUP

Daniel Kleppner, co-chair
Massachusetts Institute of Technology
Frederick Lamb, co-chair
University of Illinois
David Barton
Hanover, New Hampshire
Roger Falcone
University of California, Berkeley
Ming Lau
Sandia National Laboratory
Harvey Lynch
Stanford Linear Accelerator Center
David Moncton
Argonne National Laboratory
David Montague
LDM Associates
David E. Mosher, staff director
RAND
Lee Murrer
CARCO-West
William Priedhorsky
Los Alamos National Laboratory
Maury Tigner
Cornell University
David Vaughan
RAND

INSIDE THE BELTWAY: *A Washington Analysis*

Chairman of the Board

By Michael S. Lubell, APS Director of Public Affairs

Come August, throngs of Texans leave the Lone Star State to escape the blistering heat of the dusty plains. Not so with President Bush, who traded Washington's summer torpor for triple- digit temperatures on his Crawford spread.

But while Dubya was refreshing his mind and spirit in a most improbable fashion, some of his operatives remained at their DC desks developing a plan to squeeze better performance out of the federal research portfolio. What they seemingly hatched is an industrial model that focuses principally on short-term performance. Here's what's behind their thinking.

Where most policy analysts see America's R&D enterprise as the best engine of economic productivity ever designed, this Administration's play makers see failure. The kernel of their view appears in a report released by the Office of Management and Budget in late August. "We can rarely show what our R&D investments have produced, and we do not link information about performance to our decisions about funding," it complains.

I guess they think that someone waved a wand and bioinfomatics, genomics, information technology, lasers, materials, MRI and the Web magically appeared. Either the assertion reflects ignorance, or it contains a hidden message. Judge for yourself.

The President's Management Agenda, the OMB says, "reflects the Administration's commitment to achieve immediate, concrete, and measurable results in the near term." The message: Forget how we got here, or where we will be in ten years time. As with industrial labs, next quarter's corporate bottom line is all that matters.

The Department of Energy, everyone's whipping boy, will be the guinea pig for the new budgeting model. For applied research and development programs, DOE and OMB will use performance metrics that are designed to increase "expected efficiency" by no less than 10 percent. And DOE's efficiency, OMB notes, will be measured by how much a program can be expected to increase oil production, reduce consumption or cut pollution.

Any proposed new program will have to guarantee that it will perform in the top 25 percent of the existing programs. Implicit in this directive is that much of the current applied research portfolio isn't worth a dime of taxpayer's money. OK, maybe a dime, but not a dollar.

The report also takes a subdued swipe at the way DOE manages its basic research portfolio. Those programs, OMB notes, will be targeted at "improving the quality and relevance of their research." Although publicly the report is silent on how quality and relevance will be determined, privately DOE acknowledges that its science portfolio in the aggregate will be judged by how much it is expected to contribute to economic growth over the next three years.

Three years, in case you have forgotten, is when the next presidential election takes place. Call me a cynic.

If the OMB report truly captures White House thinking about R&D, the Fiscal Year 2002 budget end-game this season will be a tough one for science. Don't expect the Chairman of the Board, who sits in the Oval Office, to come to its rescue.

Several months ago, I forecast that the science budget would be squeezed this fall, largely by the $1.35 trillion tax cut and White House demands for major increases in defense spending. The economic slowdown has now made the squeeze a reality.

Here's how the budgetary landscape shapes up. The Republicans, who control the House and the White House, want to spend $35 billion dollars more on defense. The Democrats, who control the Senate, want more money for education, transportation, the environment and a variety of other popular social programs. Both political parties hew to the same total spending, because they swore that they wouldn't raid the "Social Security lock box," and that's all that's left of the surplus.

Both parties are in a bind. The Democrats can press their advantage in the Senate, but they don't have the votes to override a presidential veto,

See BELTWAY *on page 5*

LETTERS

Lindsey Off Base on Energy

Lawrence Lindsey's Back Page article on energy, growth, and the environment is quite telling in its choice of words. Twice Lindsey says that the United States should be seeking ways to escape the environmental consequences of global warming. Nowhere is a reduction in greenhouse gas emissions, as compared to today, contemplated.

Even more troublesome is the lack of discussion concerning an allowance for developing nations to ultimately generate per capita greenhouse gases comparable to those of the US. It seems that we have become a fat and greedy people with only a warped self-serving view of the future. Lawrence Lindsey would have us man the dikes while ignoring the cries of our neighbors. Somehow I don't think it will work.

Paul Harris
Little Egg Harbor, New Jersey

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In the 1950s I was surprised when my office-mate at an oil company research laboratory was transferred to Long Range Planning and reported to me that this meant the next five years. Thus I was only disappointed but not surprised to see the survival of this viewpoint in Lindsey's Back Page article.

I suspect that an essential function of all religions in the past was to promote the altruism and the associated view essential to the long term survival of their group. I suspect that they were not aware of this function, since I do not see anywhere any indication of religious efforts to deal with the incompatibility of short-term planning with the inevitable need to take finite resources into account before we hit a brick wall. Do most physicists really believe that a technological solution for this problem exists, or do they just despair of finding an actual solution that can be implemented?

Elmer Eisner
Houston, Texas

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I am writing in response to Lawrence Lindsey's Back Page column in the July issue of *APS News*. He argues (disingenuously, I believe) from several invalid premises.

First, he ignores that fact that the great increase in electricity and home heating fuel prices had little to do with the actual costs to producers. Rather, thanks to deregulation, they saw an opportunity and charged what the market would bear and then some, recording record profits in the process and bankrupting the distributors. This situation will not improve until the government steps back in and imposes limits.

Second, he neglects to mention that what progress we have made in energy efficiency and pollution control only occurred because of government mandates, with the affected corporations fighting every inch of the way. In fact, they continue to lobby for weakening of our environmental laws. This implies that the only way CO_2 emissions will be reduced is under the force of law and international treaties. Unfortunately, corporations have found a sympathetic ear in the Bush administration and the Republicans in Congress, so that it is unlikely that much progress will be made for at least four years.

Michael Bleiweiss
Methuen, Massachusetts

Visa Reform Needed

I just received the *APS News* May 2001 issue in which the visa problems of physicists are addressed. In my position as a professor in Europe and consultant to the US industry I have had several students who did their master's thesis or PhD work in my laboratory in the States. In order to do this they have to apply for a J-1 visa, which expires after a period of 3 years. PhD work usually takes 2-3 years, before they can pass their exam to defend their thesis at my university. Some students did excellent work and applied successfully for a European fellowship for postdoctoral studies. However the visa policy of the US does not allow them to pursue their postdoctoral years on the basis of a fellowship. This is only possible if they are fully employed as a postdoc either by a university or by a US company.

On the other hand the conditions of the fellowship often state that the research work must be carried out in a foreign country in a place of high scientific quality and reputation. It is obvious that this is not possible if the student has used up his 3 years of J-1 to do his thesis work. The negative effects are 2-fold: a) Top students will not get their fellowship and their career is jeopardized by this visa policy. b) US universities or industrial companies who do not have the money to hire postdocs or even employees on a permanent job basis, suffer also from the disadvantage of this policy.

I think many European students would be grateful to the APS if they could take this problem to the Department of Foreign Policy or INS or whoever is responsible for this situation. APS could suggest making a clear distinction between students who do their thesis work in the States and those who apply as postdocs, regardless of whether paid from fellowships or by a US employer. One could give the visa a different name: Maybe S-1 for students, and J-1 for postdocs based on a granted European fellowship. I do not think that this solution would be a disadvantage for the US. On the contrary, they could benefit from the work of our best European talents.

Ernst Bucher
University of Konstanz, Germany

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VIEWPOINT…

"SI" Equals System Imbecilic

By Charles W. McCutchen (Overage physicist)

In the August/September issue, in a letter on the question of units, Ralph Tykodi wrote, "Publications of APS should follow International Recommendations on notations and terminology." Charles W. McCutchen has a different idea. —Ed.

Systeme Internationale units are the product of successive episodes of bloody-mindedness, a British term that means injuring others to demonstrate one's importance. The metric system got its start after the French Revolution. Before that there was anarchy in detail but agreement on principle. Different parts of Europe had different inches, but they were all about the length of a finger bone, the diameter of a crude broom stick. (The foot needs no explanation.) Units were chosen for ease of use.

To the French revolutionaries the units were part of the bad old days. Presto: enter the centimeter and decimeter, of which the inch is not far from the geometric mean. The new units were one-in-the-eye for royalty and everybody else. They were almost as far as possible from the units that people had chosen for themselves.

The meter is related to the Earth, but who cares? And if we did care, twice the polar diameter of the Earth is a billion inches to about a tenth of a percent.

Ordinary people kept using the units they liked. When I was in Stavanger in Norway in 1977 vegetables in the open-air market were priced by the half-kilogram, approximately one pound. English and American engineers likewise stayed with the familiar, making accommodations like the decifoot and kilopound where useful. Scientists and Continental European engineers, being more under the thumb of national academies, got stuck with the metric system. They did the best they could. Because the dyne/cm^2 was ridiculously small, pressure got measured in kg/cm^2 ~ 10^6 dynes/cm^2 ~ 1 atm. The Angstrom was coined, 10^{-8} cm, a bit less than the spacing between atoms in a solid. It makes molecular structures easy to visualize.

Enter the reformers, overage physicists otherwise unemployable. They replaced cgs units by mks. As a young physicist I learned both, in reverse order. Both worked. Each had advantages for particular applications.

Though the metric system was awkward for most users it was convenient for some—how undemocratic!—until the next reformers struck. Which they did, with the fervor of Robespierre, the self-righteousness of Torquemada, the totalitarian ideal of conformity and the fascist weapon of compulsion. The metric system has all powers of ten available for use. What anarchy! People must be controlled, forced to use only those powers selected by the poo-bahs.

The new abomination is SI. Because the size of approved units progresses by thousands it is awkward for almost everybody. Democracy has been achieved. The Angstrom is *verboten*. One must use nanometers, which make molecular structures harder to think about. The Pascal (one apple-weight per desktop) is the approved unit of pressure, perfect in the eyes of the little Hitlers because it is unintuitive and unpopular. Here even scientists rebel. Many authors give pressures in atmospheres, thus using a familiar and

See VIEWPOINT *on page 5*

Law of Cat Obstruction

As a physical chemist, I have always found *APS News* interesting. I have also been impressed with the writing in *APS News*, and I have found it quite enjoyable to read. As I am also an animal lover who lives with two incredibly sweet cats, my interest was particularly sparked when I noticed the "Zero Gravity" section in the last issue of *APS News* (July 2001), entitled "Feline Physics." I was enjoying the various physical laws that cats obey, when I was chagrined to find that one of them, the Law of Cat Obstruction, contains a rather annoying error. While it is entirely possible that this usage is so widespread that some will say that I must accept it as standard, I am quite sure that no self-respecting feline would ever think of "laying" on the floor. Mine, at least, prefer to "lie" there. Of course, I suppose the error would be perfectly understandable if the column were written by a "lay" person.

Louis I. Grace
Santa Barbara, California

Cats are mammals, and like most mammals, they do not lay eggs, although they may lie on the floor.

John Mcintosh
Middletown, Connecticut

In Praise of Overhead Projectors

A letter writer recently asked, "Why did these speakers [at a recent meeting]...use transparencies and not a laptop and projector like [all the speakers at] every non-physics conference I've been to?" (*APS News*, July 2001). Three simple reasons can be given.

1) Overhead projectors for transparencies are ubiquitous. They are part of the standard equipment of lecture and conference halls everywhere. 2) Overhead projectors are simple and reliable. In contrast, the systems of laptop computers hooked in to projectors are so complex that they frequently fail. 3) Preparation of black and white transparencies for use with overhead projectors can be done on almost any office copy machine in the country.

Now let me make two assertions in regard to laptop computers, projectors and presentation software such as PowerPoint. 1) Most physicists seem to lack even the most rudimentary understanding of the geometrical optics of visibility and legibility of materials to be projected in a lecture setting. 2) Presentation software such as PowerPoint has done more to degrade the quality of visual communication than anything in history.

The advent of exotic and versatile presentation software opens up whole new realms of optical screw-ups. Hundreds of marginally legible fonts are available in many sizes and these can be combined with all manner of distracting geometric and colored camouflage. The result is attractive non-communication in which the presentation medium replaces the message. Only with this exotic software can one compose a slide using small black type on a dark blue or green background, or present important messages in yellow type on a white background. The composer may have been able to read the image close-up on a computer screen, but when the image is projected for a large audience, it can't be read by a person past the third row.

I think it is important that we teach physics students the simple geometrical optics of visual communication using reliable overhead projectors. Once this fundamental skill is mastered, they can use presentation software, learn about the use of colors, and take their chances that their laptop - projector system will work as they wish.

Albert Allen Bartlett
Boulder, Colorado

zero gravity

Haggar Physicists Develop 'Quantum Slacks'

DALLAS—At a press conference Monday, Haggar physicists announced the successful development of "Quantum Slacks," attractive, wrinkle-free pants that paradoxically behave like both formal and casual wear. "With this breakthrough, pants enter a whole new dimension," said Dr. Daniel Chang, head of the Haggar team. "Conventional notions about the properties and possibilities of slacks have been completely turned on their head."

Though long dreamed-of by theoretical physicists and science-fiction authors, the quantum slacks represent the first wearable pair of non-Newtonian pants, putting America one step closer to a complete casual wardrobe that transcends classical physics. "For decades, we conducted level-one physics experiments in which we collided individual subatomic particles in a highly controlled laboratory setting," Chang said. "But an array of technical hurdles kept us from taking the next logical step: colliding pants."

Quantum slacks featured in Haggar's spring 2001 catalog

Scientists at Haggar's Pants Propulsion Laboratory bombard khakis with high-speed pleat particles.

Preliminary tests conducted last month at the Haggar Pants Propulsion Laboratory in Dallas indicate that the quantum slacks, generated by smashing together two larger sizes of slacks at near-light speeds, defy scientific explanation. Said Chang: "We placed the pants in a casual lawn-party setting and discovered them to be functional and comfortable. But, against all logic, in subsequent tests the pants performed equally well at a formal business luncheon. This represents a baffling, 'Schrödinger's Pants' duality. The results even fly in the face of Einstein, who preferred wool trousers."

Subsequent experiments yielded even more puzzling results. "We have attempted to measure the exact dimensions of these counterintuitive slacks, if only to know what rack to store them on," Haggar physicist Dr. Mattias Kohl said. "But we've learned, to our dismay, that if we measure length, we lose sight of waist size and vice versa. These slacks defy all traditional means of measurement." Added Kohl: "Additional study and data-gathering is proceeding at a slow pace, as the pants have a strange tendency to vanish and reappear elsewhere. Understanding and harnessing this trait is essential before we can find a way to distribute the slacks to stores."

More exciting, Kohl said, is the potential for gaining insight into the very origin of trousers itself—a breakthrough he described as "within walking distance." "Scientific law holds that any given piece of clothing becomes less fashionable over time," Kohl said. "However, at the quantum level, we have found that certain styles of Haggar slacks actually grow more fashionable, suggesting the existence of 'slachyons,' theoretical pants that travel backward in time."

In the face of these bizarre phenomena, the Haggar physicists remain optimistic. "Mankind's knowledge of pants technology has been advanced immeasurably," Kohl said. "We cannot overstate the revolutionary nature of this breakthrough. We are on the verge of unzipping the secrets of creation and peering into the pants of God Himself. We are about to discover the very fabric of the universe, and it appears to be a smart cotton-twill weave."

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Viewpoint, *from page 4*

enduring standard. Their papers will be understandable after the Pascal is forgotten—which it will be if scientists have any sense.

People who actually use units invent delightful and practical ones. As well as the Angstrom there is the ultracentrifugers' Svedberg, 10^{-13} cm (i.e. one Fermi/sec per g).

And they use happy coincidences like the density of water being about 2 slugs per cubic foot, thus the stagnation pressure in pounds/foot^2 about equals the speed in feet/sec squared, a handy thing to remember if you are designing a fast boat.

If the height, *in feet*, of the center of gravity of a box-shaped boat above its center of buoyancy exceeds the square of the boat's width *in feet* divided by its draught *in inches* the boat will capsize. Run those numbers through your head before you put a tall load on your barge.

For airliner design and operation 100 kg, the mass of a passenger and baggage, is a convenient unit. Call it the pax. An airplane that carries 400 passengers and weighs 400,000 kg = 4,000 pax when loaded has a payload 10% of its gross weight. If, at the airport, 10 passengers get off, 10 pax of fuel can be added for the same total weight. Do these calculations in kg or tonnes and mistakes can crawl in.

We who do and make things have let the units dictators force us to use the metric system, and then keep us from using two thirds of that. We should throw off the yoke. We should use whatever units are convenient.

Beltway, *from page 3*

neither there nor certainly in the House. The President can call on Congress to deliver the defense spending bill to him before any others, as he already has, but Senate Democrats, who control the sequence of appropriations bills, can refuse to comply, as they already have sworn they would not.

The outcome could be a stalemate with a year-long continuing resolution for many programs, which would keep spending at or below current-year levels. The two parties could also duke it out in the media for much of the coming year, hoping to get an early boost for the 2002 congressional election in the process.

There is a third possibility. They could strike a deal to increase defense spending significantly — but not by the full $35 billion — and add serious money to education and social programs — but not as much as the Democrats want, squeezing everything else in sight.

None of these scenarios bodes particularly well for science. It is doubtful that the numbers will rise much above the average of the House and Senate appropriations bills. And there's a good chance they won't make it that far.

And with a Chairman of the Board using his MBA training to orchestrate future White House budget policy, science may have to learn to live with a quarterly earnings mentality or suffer meager offerings for the next few years if it doesn't.

Letters, *from page 4*

Olympiad Missed Some Years

Richard M. Todaro published an article in the July 2001 issue of the *APS News* on the selection of the finalists for this year's Physics Olympiad US team. He writes, "Although the competition has been held every year since 1967, originally it included only Soviet-bloc nations and the US did not participate until 1986."

In fact, no Olympiad was held in 1973, 1978, and 1980. Also, although the US joined the competition quite late, other Western countries did so much earlier. France and the Federal Republic of Germany participated already in 1975 and two Olympiads were organized in the West (1982, Malente, FRG and 1984, Sigtuna, Sweden) before the US sent a team the first time to the 1986, London competition.

Laszlo Takacs
University of Maryland, Baltimore

Update on Large Numbers

While I was flattered and honored that *APS News* chose to publish my little toy article "A Fuga Really Big Numbers" in the April 2001 issue, I was quite taken aback to find it published at all, since no one had ever written me to ask for permission. I only stumbled across the publication of the article while doing some random web wandering one night. Equally amazing was that they did not put in a web link to my site (http://members.aol.com/acockburn/). The article was something I wrote one evening, and put on my web site as a draft, for the amusement of people who occasionally visit my site, until I could think of what to do with it next.

Of the people who replied to the draft on my Web site, Stephan Houben, a PhD student in numerical mathematics at the Eindhoven University of Technology, was the first to catch that I had put the parentheses in the wrong order. We conjured up the name Megafuga to fix that. Feynman's Hair Raiser Function described by Lorin Vant Hull, is the Megafuga function, I think, and I feel absolutely no embarrassment at having reinvented something Feynman invented 50 years ago — quite the opposite, I'm delighted. Sunir Shah wrote that not only was Megafuga already known as "tetration", but there is a standard way of writing it as repeat exponential, putting the superscript to the left of the number it raises. Megafuga(4) is (4 tetrating 4), which is, someone computed, something like $10^{1.5}$ googol. Truly a big number.

We played with these things for a while, becoming old 8-year-olds again, until Stephan Houben suggested we stop using kid-style repetition: "The game is more interesting if you can do it without referring to another function mentioned previously at any time previously during the game". He offered the Ackerman function, which creates new, bigger functions as it goes. Megafuga / tetration (n) is only Ackerman[4](n). Then someone wrote in with Graham's number and someone else with reference to Conway's "Book of Numbers" with some other very large numbers and functions in it.

Interestingly, none of the readers in the previous six months noticed what Virginia Trimble did, the goof of having 10^5 be ten thousand (blush). Spell checkers don't catch that, and evidently, neither do more than one in 10^3 web readers. I guess that's what peer review is about.

The publication gaffe aside, I'd like to thank *APS News* for thinking the article worth your reading and those of you who replied. And even after all this discussion of functions, I think that Kieran's "gargoogolplex" will remain a handy number to stick into any function (just think of gargoogolplexation of gargoogolplex!).

Alistair Cockburn
Salt Lake City, Utah

The Editors reply: It is certainly the policy of APS News to seek authors' permission before reprinting original material, whether in the "Zero Gravity" column or elsewhere. Unfortunately, Dr. Cockburn's article — first sent via a private mailing list — appears to have slipped through the cracks somehow. We humbly apologize for the mix-up.

PROLA isn't free

Wonderful! PROLA is complete. And so, I go in, find an ancient (short) paper and discover that being a long-time APS member is insufficient to let me SEE the paper. Back to the dusty visible library volumes.

Albert English
Delray Beach, FL

Thomas McIlrath, APS Treasurer/Publisher, replies: PROLA (http://prola.aps.org) has proven to be an outstanding success, containing all of Physical Review, Physical Review Letters and Reviews of Modern Physics from three years ago back to 1893 (the past three years are accessed through current subscriptions). The Society is very proud of its success. The creation of PROLA cost more than $2,000,000 plus intense dedication by a few truly outstanding individuals. This initial cost has been absorbed in the general budget and reserves. However, there is an ongoing cost of updating links, adding new material, maintaining servers, etc. This cost is covered by subscription fees, mainly from libraries. Library subscriptions allow unlimited access to their faculty and staff. (Librarians often ask us to remind members that their campus access is not free, but is paid for by the library). Individuals can subscribe for $100 per year or they can buy articles on a pay-per-view basis. The Society is not-for-profit and continues to price its journals at cost and attempts to spread its charges evenly through the community, but someone has to pay the bills.

Mass Media Fellow Relishes Drama of Science

Physicists are notorious for their inability to communicate their research to the general public, but as public education and outreach becomes more crucial in an increasingly technological society, more and more scientists are taking steps to become more media savvy. One such physicist is Sharmila Kamat, a graduate student at Case Western Reserve University (CWRU) who spent this past summer at *US News and World Report*, based in Washington, DC, as an APS Mass Media Fellow.

Kamat had done quite a bit of writing while an undergraduate in India, most notably for *Femina*, the top English-language women's magazines in the country. She came to the US to pursue graduate studies in experimental particle astrophysics at CWRU, where she is part of the cryogenic dark matter collaboration searching for Weakly Interacting Massive Particles (WIMPs). It was Lawrence Krauss, head of the physics department at CWRU and a best-selling science author himself (*The Physics of Star Trek*, *Atom*), who noted her interest in both science and writing, and suggested she apply for the fellowship.

Kim Quigley/APS

Sharmila Kamat

Not surprisingly, Kamat's science background has come in handy during her fellowship. She wrote an article on the results of the Maxima, Boomerang, and DASY collaborations to map the Cosmic Background Radiation, first announced at the 2001 APS April Meeting in Washington, DC (see *APS News*, June 2001). Unfortunately, the breaking news on solar neutrinos took editorial precedence, and her story was postponed. But writing the piece proved a highlight of Kamat's fellowship experience. "It's always believed that physicists are incomprehensible, but I spoke with physicists who were very media savvy," she says. She also enjoyed the challenge of writing about a physics topic in a way the average layperson could understand.

Kamat has returned to her graduate studies at CWRU, but hopes to continue writing occasionally on a freelance basis. She has yet to decide how best to divide her time between a research career and science writing, but is encouraged by the increased coverage given to science in major newspapers and magazines, aided by such high-profile events as the controversial seminar on cloning held this past August. "That seminar really brought out the drama of science," she says of the experience. "This fellowship gave me the opportunity to get a front seat for the unfolding of that drama."

A second Mass Media Fellow, Maria Cranor, spent the summer at the *Albuquerque Tribune* in New Mexico. Cranor is a former intern in the APS Office of Public Affairs in Washington, DC, currently pursuing dual degrees in physics and psychology at the University of Utah. Cranor came to physics relatively late, studying anthropology and African pre-history at Berkeley, becoming a world traveler and avid rock-climber, and working as a marketing director of a manufacturer of climbing equipment. Eager for a new career path, she chose physics, and like her OPA internship last summer, the Mass Media fellowship offers a taste of the wide variety of careers available to physicists today.

APS Members Among "America's Best" in Science

Two long-standing APS members made the final cut for a special issue of *Time* magazine, identifying 18 best and brightest American minds in science and medicine. The August 13 cover story named Carlos Bustamente of the University of California, Berkeley, as the best scientist in molecular mechanics, while. Princeton University's David Spergel won the top spot for astrophysics.

Bustamente came to the US from Peru 26 years ago as a Fulbright Scholar, and succeeded in measuring the elasticity of a DNA molecule in the early 1990s with colleagues at the University of Oregon — establishing that large molecules could be mechanically manipulated in the process. Now an investigator at UCB's Howard Hughes Medical Institute, Bustamente went on to use an atomic force microscope and laser tweezers to read the topography of molecules and manipulate them. By 1997 he had managed to grasp a single protein and pull it apart, to better study how proteins and nucleic acids fold into complex structures, which would have important ramifications for drug designers. And last year he applied the lessons learned from his past research to describe, step by step, how a lone enzyme copies a DNA sequence into RNA.

Spergel is a theoretical astrophysicist whose contributions include the discovery that the Milky Way galaxy is not just a simple spiral of stars of gas, but rather a complex construction with warped edges and a bar of stars across the middle. He has also grappled with the problem of dark matter and cosmic structure, most notably why galaxies tend to clump together rather than spread uniformly through space. Recently his work has taken a decidedly experimental bent: he helped design the Microwave Anisotropy Probe (MAP) satellite launched this past June to probe the outer edges of the universe. In the months to come, he will help decipher the data the 1800-pound satellite beams back from space. And he has already been asked to help design a second spacecraft to find Earthlike planets orbiting other stars, resulting in a revolutionary idea for a telescope capable of spotting a dim planet in the glare of a bright star.

To read more about America's Best in science and medicine, see the interactive Website at http://www.cnn.com/SPECIALS/2001/americasbest.

OPA Intern Gets Crash Course in Science Policy

Grappling with today's hottest science policy issues was just another day at the office for Stephanie Young, a senior at University of California, Berkeley, who spent this past summer as an intern at the APS Office of Public Affairs in Washington, DC. A physics and astrophysics major, Young applied for the internship as a means of exploring alternate career options for people with backgrounds in physics. The internship "sounded perfect for me. It's directed at physics majors who are also interested in politics and I thought it would be a fun change of pace," she says.

Upon arrival, she was immediately plunged into a crash course in the political process, attending Congressional hearings on climate change and national missile defense, getting involved with a proposed Congressional bill to reinstate the Office of Technology Assessment (see *APS News*, August/September 2001), and helping produce "What's New," the Society's weekly electronic newsletter on science policy issues. "I've really been able to get a sense for how the whole process works, and to see the politics involved firsthand," she says.

As for the future, Young remains undecided, although her experience this summer has definitely piqued her interest in the possibility of returning to DC after she graduates, either working on science policy issues or in a Congressional office, before applying to graduate schools in physics. "I'm in the process of trying to decide what direction I want to take, career-wise, and it's a very one-directional process at Berkeley," she says, where the emphasis is on the traditional career path of undergraduate work, graduate school, postdocs, and tenure-track faculty positions. "This summer, I saw physicists doing other things, like science writing, science policy, and lobbying. There's so much else out there that science majors can do."

Washington interns have been the subject of much negative media attention in recent years, but Young isn't likely to be easily cowed or dissuaded from her goals by any real or imagined risks. She's spent the last year volunteering as a math tutor to prison inmates at San Quentin in her spare time. San Quentin is one of only a handful of prisons nationwide that offers educational programs for inmates; in fact, inmates can earn the equivalent of an AA degree at the prison.

"It's definitely intimidating the first few times you go there," Young admits, but adds that program participants are carefully screened. "They're not going to put you in a classroom with Charles Manson." Despite the strain on her already hectic schedule, she finds the experience rewarding, even though the mathematics involved is very basic addition and subtraction. "It's very satisfying to know they'll come out of prison with basic math skills," she says. "It makes me feel like I'm doing something worthwhile to help the community in some way."

Persecutions, *from page 3*

international grants, traveling to international conferences, and hosting foreign colleagues.

The move was ostensibly an effort to protect state secrets, but critics charged that it was nothing more than a revival of Soviet-era authoritarian rule under the Federal Security Service. Known by its Russian abbreviation FSB, it is the internal state security service and direct successor of the old KGB. Current Russian President Vladimir Putin served as a high-level KGB official in the late 1980s and early 1990s.

The presidium directive triggered alarm among scientists abroad and, to a lesser extent, in Russia itself. It also prompted a warning from financier billionaire George Soros that he would halt his multi-million dollar philanthropic and business activities in Russia.

"I feel it very personally because, I've spent well over $100 million in supporting Russian science, and I would certainly not have been either willing or able to do it if such an order had been in existence," Soros said at a news conference in Moscow in June, as reported by the Associated Press.

The new directive, as reported in the August 10, 2001 *Science*, merely requires scientists to inform their supervisors in writing about any foreign activities.

The United States government, which had taken a wait-and-see attitude toward the May directive, accepted the academy's explanation that it had indeed replaced the initial resolution with a much less restrictive one dealing only with "secret programs."

"They realized it was causing an outcry and they repealed the decision, but they made a distinction between people who work on secret programs and people who work on non-secret programs," said Norman Neureiter, the science and technology adviser to the Secretary of State. "Otherwise, it has been repealed, and only five percent of the people in the Russian Academy of Sciences work in such secret programs."

Neureiter said that academy vice president Nikolay Pavlovich Laverov had personally "sought to reassure us absolutely that it wasn't a crackdown on academic freedom."

Critics like Daniel Mattis, a professor of physics at the University of Utah and chair of the APS Committee on the International Freedom of Scientists, were not impressed with the new directive's secret and non-secret distinction. "A secret is whatever they want to say it is," he said.

Mattis pointed to the case of Valentin Danilov, the head of the Thermo-Physics Center at Krasnoyarsk State Technical University, who was arrested and jailed in February and subsequently charged in April on charges of selling state secrets to a Chinese company.

As Mattis outlined in a letter to *Physics Today* (August 2001), Danilov was the signatory on a legal contract between his university and a Chinese company on a project that used information declassified by the Russian government in 1992 and that had been available in various, public forums.

"Danilov had taken material from public sources, and now he is languishing between life and death," Mattis said, referring to Danilov's reportedly seriously ill condition following a heart attack in June.

Mattis said that anyone who has fallen afoul of the authorities can be arbitrarily charged. "There are people who have been jailed because they've published in foreign articles things about pollution in Russia, and they've been accused of espionage. They are not violating any laws," he said.

Another case he cited is that of Igor Sutyagin, a physicist and historian who studied military-civilian relations in Russia and other post-Communist countries. Sutyagin was arrested and imprisoned in October 1999 on charges of high treason and espionage for allegedly passing on classified information to foreign intelligence services.

Mattis said that as in Danilov's case, Sutyagin used materials that were public and had already been published.

"Materials during this research were reportedly taken from articles published in the Russian press [and] there has been no proof from the FSB – or any other credible source – to substantiate this accusation," Mattis wrote to President Putin in a letter dated July 25th.

And Mattis noted that even if an individual is eventually acquitted – as was the case with Alexandr Nikitin, an environmentalist accused of divulging state secrets while protesting nuclear plant and submarine safety – it can still carry a very high price.

"You can be prosecuted and exonerated, but what good does it do you if you've been in jail for four years?"

ANNOUNCEMENTS

DPP Distinguished Lecturers 2001-2002

The Division of Plasma Physics of the APS announces the Distinguished Lecturers in Plasma Physics for 2001-2002. This Program is intended to share with the larger scientific community exciting recent advances in plasma physics.

Under the Plasma Physics Travel Grant Program funded by the Department of Energy, the lecturers are available for talks at US colleges and universities for the academic year 2001-2002. Their travel expenses will be supported by the grant; preference will be given to invitations from colleges and universities that do not have substantial programs in plasma physics. The Lecturers may be invited by contacting them directly.

John Apruzese
apruzese@ppdmail.nrl.navy.mil
The Physics of Radiation Transport in Dense Laboratory Plasmas

Palmyra Catravas
PECatravas@lbl.gov
Radiation Sources and Diagnostics with Ultrashort Electron Bunches

Gurudas Ganguli
gang@ppdmail.nrl.navy.mil
Plasma Dynamics in the Earth's Auroral Region

Martin Greenwald
g@psfc.mit.edu
Turbulence, Transport and Confinement in Fusion Plasmas

Chan Joshi
joshi@ee.ucla.edu
High Energy Density Science with Ultra-relativistic Electron Beams

Mark Koepke
Mark.Koepke@mail.wvu.edu
Interrelated Experiments in Laboratory and Space Plasma Physics

Cynthia Kieras Phillips
ckphillips@pppl.gov
Wave Connections in Space and Fusion Laboratory Plasmas

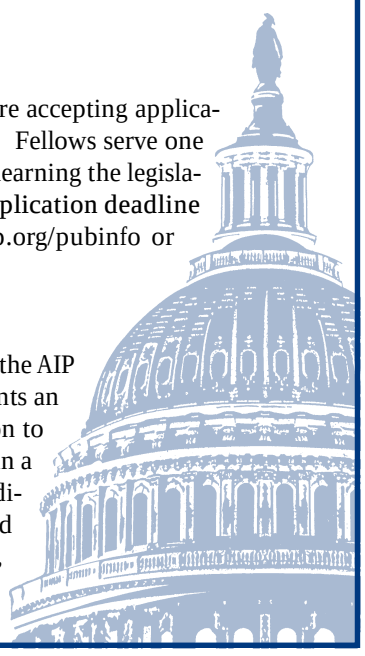
FELLOWSHIP PROGRAMS

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

AIP STATE DEPARTMENT SCIENCE FELLOWSHIP

The American Institute of Physics (AIP) is now accepting applications for the AIP State Department Science Fellowship. This fellowship program represents an opportunity for scientists to make a unique and substantial contribution to the nation's foreign policy. Each year, AIP sponsors one fellow to work in a bureau or office of the US State Department, becoming actively and directly involved in the foreign policy process by providing much-needed scientific and technical expertise. Application deadline is November 1, 2001. For more information, visit: http://www.aip.org/mgr/sdf.html



APS News regrets the erroneous spelling of Professor Henry DeWolf Smyth's last name in the letter from Val Fitch in the August/ September issue. We are grateful to APS Editor-in-Chief Marty Blume for this editorial correction.

APS GRANT ADMINISTRATOR NEEDED

The American Physical Society (APS), seeks a professional grant administrator to work for the Physics Teacher Education Coalition (PhysTEC), a five-year project to improve the science preparation of future teachers. This is a joint effort of the APS, the American Association of Physics Teachers and the American Institute of Physics. The goal of PhysTEC is to encourage physics departments, in collaboration with departments of education, to produce more and better-prepared science teachers who are committed to student-centered, inquiry-based, hands-on approaches to teaching. Six initial universities have been selected to participate.

The chief function of the job is handling the day-to-day activities and maintaining the PhysTEC database. Responsibilities include maintaining the Web page, creation of a newsletter, travel planning and accounting, making small group presentations and assisting with publications.

The qualified applicant will have the equivalent of a bachelor's degree in physics or in some other physical science such as chemistry, computer science, mathematics, or engineering (Masters degree preferred), and at least 2 - 5 years of teaching secondary school or college level.

Required skills include computer competency in Excel and MS Word (Access and web page design/maintenance abilities a plus). Must have excellent communication and writing skills, be able to work effectively with science and education faculty, be reliable, and have the ability to administer multiple programs. Competitive starting salary, outstanding benefits package and attractive work environment offered. Visit our website at http://www.aps.org. To apply, email cover letter, including salary requirement, resume and list of professional references to stein@aps.org.

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Now Appearing in RMP...

The articles in the October 2001 issue of *Reviews of Modern Physics* are listed below. For brief descriptions of each article, consult the RMP website at http://www.phys.washington.edu/~rmp/current.html. *George Bertsch, Editor.*

The interstellar environment of our galaxy — *Katia M. FerriFrè*

Traffic and related self-driven many-particle systems — *Dirk Helbing*

Vortex states and quantum magnetic oscillations in conventional type-II superconductors — *Tsofar Maniv, Vladimir Zhuralev, Israel Wagner, and Peter Wyder*

Particles and fields in fluid turbulence — *G. Falkovich, K. Gawedzki, and M. Vergassola*

Noncommutative field theory — *Michael R. Douglas and Nikita Nekrasov*

The world of the complex Ginzburg-Landau equation — *Igor Aranson and Lorenz Kramer*

Colloquium: Condensed phases of gases inside nanotube bundles — *M. Mercedes Calbi, Milton W. Cole, S. M. Gatica, M. J. Bogan, and G. Stan*

Reviews of Modern Physics
University of Washington
Physics/Astronomy B42
Box 351560
Seattle WA 98195
e-mail: rmp@phys.washington.edu
phone: (206) 685-2391

Bachelors, *from page 1*

By contrast, women earned 13 percent of the physics PhD degrees conferred in 1999, a number up from 7 percent in 1978.

African Americans and Hispanics were once again poorly represented among bachelor's degree recipients in 1999. Only 160 African Americans received a physics bachelor's degree in 1999, a number that represents just under five percent of the total number of US citizens that received such degrees.

The 3,646 physics bachelors of science degrees conferred in 1999 was almost 40 percent below the peak number achieved in 1969 when a combination of Cold War military-industrial complex needs, the Vietnam War, and the Apollo space program helped turn out about 6,000 physics bachelor's degrees, and it is the lowest number since the mid-1950s. After dropping in the 1970s, physics bachelor's degree production was relatively flat in the 1980s before beginning its decade-long slide in the 1990s.

At the graduate level, the report found the number of Ph.Ds conferred to the class of 1999 was 1,262, a drop of about five percent over the previous year. This number is off about 15 percent from the class of 1994.

The number of physics Masters degrees conferred has fallen even more dramatically during the same period. In 1999, there were 671 physics Masters degrees conferred, down 14 percent from 1998 and off 37 percent from the class of 1994.

As with bachelor's degrees, the number of PhDs conferred in the past half century has reflected social trends and the two numbers have mostly moved in tandem. PhD degree production soared in the 1950s and 1960s before falling in the 1970s and stabilizing in the 1980s.

A notable exception occurred between 1991 and 1994, when PhD degree production spiked 34 percent even as bachelor's degree production began its decade long decline. The spike is attributable to a temporary change in US immigration policy toward Chinese students studying in the US in the wake of the Chinese government crackdown on the pro-democracy movement.

The report indicates why changes in the number of foreign students should affect the physics graduate degree numbers so much. Whereas US students accounted for 93 percent of the bachelor's degrees recipients in the class of 1999, they accounted for just 58 percent of the physics Master's degrees recipients and 53 percent of the physics PhD degree recipients among the class of 1999.

The proportion of US citizens receiving physics graduate degrees is likely to fall even more. Foreign students now comprise 49 percent of the physics graduate school population in the United States and they accounted for 53 percent of the 1999 first year graduate students.

By contrast, the number of African Americans and Hispanics receiving graduate degrees in physics remains very low. Only 24 African Americans received Master's degrees and only 10 received PhD degrees in physics in 1999. Among Hispanics, the numbers were 9 and 10, respectively.

Mulvey said that growth in the number of foreign students is likely to propel an overall increase in PhD production in coming years. His report found that for the first time since 1992, the number of first-year graduate student enrollments had a "significant increase," rising four percent over the previous year to 2,510 students, and that most of this increase came from a jump in foreign students.

"There was a six percent jump in foreign students compared to a one percent increase in US students, which equated to a four percent increase overall," Mulvey said.

In a November 2000 report, Mulvey found that 95 percent of first-year foreign students had received the equivalent of a bachelor's degree in physics. He also estimated that over half of foreign students enrolling in graduate physics programs in the United States in 1997-1998 had more than the equivalent of a bachelor's degree, with many having the equivalent of a Master's degree.

"Much of this discrepancy in educational background is attributable to the differences between undergraduate programs in the US and undergraduate-equivalent programs abroad, which may cover the physics curriculum in greater depth and require more years to complete," Mulvey wrote in that report.

THE BACK PAGE

It Takes a Real Community to Keep Physics Healthy

By Jim Tsang and Craig Davis

There are many positives for the US physics community. Intellectually, ours is a very productive era and physics remains at the forefront of innovation, invention and insight. Internationally, the US remains a destination of choice for many of our colleagues as a place to work, meet and publish. Outstanding students from around the world come to obtain their PhDs at our universities. Many of our graduates obtain outstanding positions in industry. Unemployment for our recent PhDs in 1997, the last year when detailed statistics are available, was only 0.7%, half of that for all science and engineering graduates. In that year, about half of all Federal research obligations in the physical sciences went to physics as compared, for example, to 19% for chemistry. Seven percent of the total US obligations for research in 1997 went to physics, the largest amount of any tabulated discipline except for biology.

At the same time, many of our colleagues believe this is a bad time for US physics. Our government has decreased its funding for physics research in recent years. We need to considerably increase the number of native-born graduate students. A prominent national leader ranked his undergraduate physics course as one of the worse parts of his education. We are told that while the 20th century was our century, the 21st will belong to the biologists. We feel we have an unnaturally difficult time obtaining a proper hearing for the importance of physics research to the nation. Twelve percent of our recent graduates in 1997 said they could not find full-time employment that was "closely related" or "somewhat related" to their degrees. This was the highest number for any science or engineering field.

Over the next 5 months, a series of articles will appear in *APS News* considering several aspects of the current situation of the US physics community. They will not deal with the intellectual health of our profession, which is in excellent condition. They will concentrate on providing a framework for looking at the state of our profession. They will consider our institutions and workplaces, the opportunities provided for new graduates, the frustrations that plague the careers of both junior and senior physicists, the students we attract, the education we provide, how our fellow citizens view us, and our relationship to our sister disciplines.

These articles have been created because too few APS members are trying to make a difference in how our community fares in the give and take of US society. Our love for physics causes many of us to think that only idiots cannot recognize the value of what we do, and will not generously support physics research. The record in fact shows that the physics community has many friends. In spite of what is widely accepted as pitiful efforts to educate the general public about what physics is, and why it is valuable, a majority of our leaders and fellow citizens accept that there is a minimum level of support for physics research required for the well-being of the nation.

On the other hand, they do ask that a good case be made for the next dollar that goes to physics rather than tax cuts, research in health care, aid to education, etc. The physics community has had problems with arguments about why we should get that next dollar. These arguments have little resemblance to physics, and a great deal of resemblance to history or the social sciences, where differences in personal background, experience, and circumstances can produce a decisive reordering of priorities and values. These arguments must be made both on paper, and in person-to-person encounters, through give-and-take and dialogue. The health of the physics profession today requires the active involvement of physicists, who understand what physics is, with their representatives, bosses, and other non-scientist fellow citizens. The argument can only be made when the values of the other party are recognized and understood. This cannot be done effectively by a fraction of a percent of the 40,000-person APS membership. It will require the involvement of many members, the more the better.

For this reason, these essays will not attempt to make explicit arguments on behalf of physics. They will introduce background information on several critical topics related to the physics community and its relation to the larger US community. This will allow readers to make their own arguments, and craft cases that are relevant to their experiences. The series of essays will serve as guides to a website which will be a repository of data, links to more data, and interpretive materials from which the readers can construct their own models and form their own judgments.

For all the difficulties of the present, we must acknowledge that the past half-century has been a period of tremendous growth for American physics. Our boom was fueled by several different forces. These included the intellectual power and success of modern physics, the role of the physics community in helping win World War II, the cold war, Sputnik, the space race, the end of the cold war and the opening of the People's Republic of China. While the first is indigenous to physics and continues to fuel its growth, especially in the private sector, the others are singular historic events whose impacts decline as they grow more distant. We can only guess at how the last two events affected the growth of the US physics community in the 1990s. The recent historical record suggests that our growth was not solely due to internal factors. Each of us must determine how to respond to this fact as we seek future growth in the support of physics by the public sector.

More and more physicists are working in the private sector. In many cases, their work has a strong physics character; in some cases, it is very remote from what they learned in graduate school. There are many differences between academia and industry. Understanding these differences in the present economic context will help us take advantage of them. The substantial majority of our graduate students will never be academics, and many of them will have careers in industry. Industry is an excellent home for certain types of problems and a poor home for other types. What can be done to make it a better home for physics research? How can we better train our students for future industrial careers?

When most physicists think of funding for physics research, they think of the US government. If we think of the present as hard times, we look at the steady growth of funding for biomedical research, and the lack of growth in federal funding for physics. Many of our colleagues believe that this is the product of conscious choice, a cruel division of the "research pie" that leaves us as beggars with our noses to the window of the posh biomedical restaurant. An understanding of the federal budget process shows that the science part of the budget is certainly the product of choice, but not necessarily choices about scientific priorities and opportunities. In looking at the growth of biomedical research and the NIH, there is a chicken-and-egg character to the victory that makes it hard to tell which was the cause and which was the effect. In the case of the problems of federal funding for physics research, and the budgets of the Defense Department, Department of Energy, and NASA, our problems are related to the budgetary pressures on the agencies in which physics funding is largely housed. As such, we should recognize the high regard in which the physics community is held, and must think about how to effectively communicate to our legislators and others in government our view of national needs.

Craig Davis

Jim Tsang

The doleful tale of science education in the US should be well-known. This is a critical issue for US physicists. It is critical for the pipeline that supplies new physicists, and scientists and engineers in other fields. It is critical for the creation of an informed citizenry that can make reasoned choices on the many issues with significant technical content that are part of the public agenda today. It is critical for how our fellow citizens view physics, since for many of them, their high school and college courses are their only direct contact with the subject and physicists. The quality of a teacher in this respect can cast a long shadow. The APS has a broad range of activities in education. The problems are vast and much more thought and effort is needed to produce improvements.

As rivals, Newt Gingrich and Bill Clinton disagreed on most issues. Interestingly, they did agree on the failure of the scientific community to effectively help Americans understand what it is about, what it is doing, and how it will change the future. At CalTech, in January, 2000, Clinton said, "we have not done a good enough job in helping all Americans to understand why we need very, very large investment in science and technology." A few months earlier, Gingrich wrote in an op-ed piece that was reprinted in *APS News*, "... most scientists by definition would rather be in their laboratories studying, at conferences learning, or in a classroom teaching than appearing in public settings and appealing for public support. Unfortunately, part of their mind set seems to be a determination that their work is so obviously important that they should not have to explain it...." While Bill and Newt are history now, their message is still current. In the next few months, through the *APS News* and the APS website, we hope to make clear to all members of the APS the benefits, both to the physics community and the nation, that come from an APS membership that is informed about the major issues which affect the health of the physics community in the US, and is willing to work on those issues.

Craig Davis is Manager of the Physics Department, Ford Research Laboratory. He was chair of FIAP and is now a member of POPA and the APS Council.

James C. Tsang is a member of the research staff at the IBM T. J. Watson Research Center studying the optical properties of silicon devices. He is the current Vice Chair of the APS' Panel on Public Affairs and was an AAAS-Sloan Foundation Fellow in the White House Office of Science and Technology Policy.

APS News welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org.

Salaries, *from page 1*

salaries for society members with PhDs vary with geographical location and are influenced most strongly by type of physics employment common in that region, as well as the relative cost of living.

For example, society members with PhDs working in New Mexico reported the highest median salary ($93,000) in large part because this state has a large percentage of members working in Federally Funded Research & Development Centers (FFRDCs). Members working in Washington, DC, an area affected by substantial numbers working under a competitive government pay scale, also reported a high median salary ($90,000). The lowest median salaries were in Iowa and Kansas, reflecting the lack of society members earning the high salaries in private companies or the government in those regions.

The industrial sector employs nearly a quarter of the working society members with PhDs, with a median industry salary of $90,2000. This is 7% higher than reported in the last salary survey, conducted two years ago, and part of a 17% salary increase recorded from 1996-2000. The highest median salary for PhDs in industry was in the Pacific states ($98,000), while the lowest ($55,000) were reported in the East South Central and West North Central states. Industry respondents with master's degrees had a median salary of $79,500, while those with bachelor's degrees reported a median salary of $71,000.

However, industry salaries fell below the median salary at FFRDCs, such as national laboratories. About 11% of society members with PhDs are employed in FFRDCs, earning a $96,000 median salary. The highest median salaries were reported by PhDs employed in hospitals or medical centers, at $100,000. Universities employ the most society members with PhDs. Two-fifths of PhDs who are not postdocs are employed in universities, where the median annual salary on 9-10 month contracts is $68,000, and $77,000 for those with 11-12 month contracts.

Along gender lines, female society members who earned their PhDs within the last 10 years report average salaries comparable to their male colleagues with similar experience, except for the government sector, where men in their early career reported substantially higher salaries than women in the same category. However, among late-career PhDs working in universities, women reported salaries substantially higher than those reported by men. Females with PhDs are also more likely to work part-time than men with PhDs, but the overall part-time employment rate has dropped. The unemployment rate for women remains under 2%, and for men it is less than 1%, according to Chu.