APS NEWS

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Highlights

Executive Board Passes Resolution on Office of Science Budget

Last fall, Congress passed H. R. 2419, which set the FY2006 budget for the Office of Science in the Department of Energy. This budget impacted nuclear physics particularly severely (*see related story on page 5*). At its November meeting the APS Executive Board passed a resolution expressing its distress and calling for a rearrangement of priorities in FY2007.

The following is the text of the resolution.

•*The Executive Board of the American Physical Society is greatly distressed by the damaging conference action on H.R. 2419, which eliminated the small but critical increases for the Department of Energy's scientific research programs that both houses of Congress had previously approved. The Board notes that in the face of inflationary increases in wages and energy costs, H.R. 2419 will force the Department to make significant reductions in its university programs and in operations of its national research facilities.*

•*The Executive Board also notes that: The budget adopted by the conferees rolled back funding for most Office of Science programs to levels requested by the White House last February; And at that time, in response to queries, DOE officials agreed that such budgetary levels would result in a shortfall of $100 million in university grants, amounting to a ten percent reduction in the level of scientific effort.*

•*Finally, the Executive Board notes that: The budget Congress adopted will discourage young Americans from pursuing careers in the physical sciences at a time when industrial leaders are warning that our nation is losing out in the global competition for intellectual capital; And the budget runs counter to calls by industrial leaders for sharp increases in federal investments in physical science basic research and education to address the alarming deficits in our high-tech balance of trade.*

Funding provided by H.R. 2419 leaves virtually every Office of Science program under considerable stress. For example, Brookhaven National Laboratory in New York has already announced that it is making plans to lay off 100 members of its staff and suspend activities at the Relativistic Heavy Ion Collider, which is just now reaching the peak of its scientific productivity. Similarly, Thomas Jefferson Laboratory in Virginia is making

Executive Board continued on page 5

And the textbook is thi-i-is thick....

Photo credit: Bernard Khoury

Ninety new physics and astronomy faculty attended a 3-day workshop at the American Center for Physics in College Park last November, to absorb new ideas in pedagogy from leading practitioners and researchers in physics education. The workshop is run annually by the American Association of Physics Teachers, in partnership with the APS and the American Astronomical Society, with funding provided by the National Science Foundation. Here Warren Hein, Associate Executive Officer of AAPT (left), rivets workshop participants with a key bit of information. The workshop chair was Ken Krane of Oregon State University.

Dallas To Host 2006 APS April Meeting

Approximately 1500 physicists are expected to attend the 2006 APS April Meeting, to be held April 22-25 in Dallas, Texas. The scientific program, which focuses on astrophysics, particle physics, nuclear physics, and related fields, will consist of three plenary sessions, approximately 75 invited sessions, more than 100 contributed sessions, and poster sessions. This year the meeting will be held in conjunction with the annual Sherwood Fusion Theory Conference, devoted to disseminating the latest research results in controlled thermonuclear research.

APS units represented at the meeting include the Divisions of Astrophysics, Nuclear Physics, Particles and Fields, Physics of Beams, Plasma Physics, and Computational Physics; the Forums on Education, Physics and Society, International Affairs, History of Physics, and Graduate Student Affairs; and the Topical Groups on Few-Body Systems, Precision Measurement and Fundamental Constants, Gravitation, Plasma Astrophysics, and Hadronic Physics.

In keeping with the more generalist tone of the April meeting, nine invited plenary talks will highlight the technical program (see sidebar).

APS April Meeting continued on page 7

Plenary Talks at April Meeting

Voyager Data and the Termination Lock
Edward Stone, Caltech

Liquid Phase Quark-Gluon Plasma
Barbara Jacak, SUNY, Stony Brook

Recent Results from MiniBoone
Hira Tanaka, Princeton

Neutrinos and Cosmology
Nicole Bell, Caltech

Computational Techniques and Plasma Turbulance
William Dorland, University of Maryland

Cochlear Implants and the Physics of Hearing
Ian Shipsey, Purdue University

The Science of Nanotubes*
Alex Zettl, UC Berkeley

Results from LIGO
Gabriella Gonzalez, Louisiana State University

Physics Prospects and International Aspects of ILC
Albrecht Wagner, DESY

**to be confirmed*

What's in a logo?

Here is the new logo that the American Physical Society will begin using immediately, on stationery, business cards, various other publications and the web. It differs from the old logo by virtue of the prominent inclusion of the word "physics."

The purpose of this addition is to make clear, to non-physicists, the essential nature of the society in a way that the name "American Physical Society" does not.

Marvin Cohen, who was APS President in November when the logo was approved by the Executive Board, says "I like the logo. At least now when you are in an elevator at an APS meeting and someone looks at your badge, they won't ask you about sports."

He is optimistic about the logo's utility. "I think that the new logo, if used well – perhaps with tag lines – will get us past many of the identity problems we've had. But if the logo change doesn't work, in 2 or 3 years we may consider going forward with a full name change." The issue of a name change to "American Physics Society" was explored via a member survey last summer, but was put on hold when legal and financial problems proved greater than anticipated.

(see APS News, August/September and November, 2005)

APS News staff

Hydrodynamics, Small-Scale Flows Highlight 2005 DFD Meeting

New research on the hydrodynamics of pectoral fins in fish and the dolphin kicks of Olympic-level swimmers were among the highlights of the 58th annual meeting of the APS Division of Fluid Dynamics (DFD), held November 20-22 in Chicago, Illinois. The meeting was jointly hosted by the Illinois Institute of Technology, Northwestern University, and the University of Illinois, Urbana-Champaign.

Last year marked the 100th anniversary of Einstein's "miracle year" and was designated the World Year of Physics. One goal was to communicate the excitement of physics to the general public, thereby inspiring a new generation of scientists. In honor of the WYP, the meeting featured a special public lecture by Nobel laureate Leon Lederman on science education's "quiet crisis." His lecture was followed by a reception and an exhibit of the 2005 Gallery of Fluid Motion.

Hydrodynamics. The pectoral fins of fish are designed for a great degree of control over fluid forces: they are flexible and able to change their shape, enhancing their ability to maneuver in water. However, the kinetics do not lend themselves easily to the usual analysis based on pitching or paddling kinematics, or lift/drag-based propulsive mechanisms.

In order to glean new insights into the hydrodynamics of pectoral fins, researchers at Harvard University and at George Washington University used two-camera high-resolution digital video to measure 3-D fin conformation of fish during steady swimming and while maneuvering. They also performed high-fidelity numerical simulations of the hydrodynamics and thrust performance of the pectoral fin of a bluegill sunfish. The measurements and simulations showed that the fin produces a large amount of thrust at all phases in the fin motion, and produces a distinct system of connected vortices.

Similar numerical simulations are being used to study the fluid

DFD Meeting continued on page 5

Michelson and Morley Get Their Due

Photo credit: Mike Sands

On November 14, Case Western Reserve University held a celebration of the World Year of Physics, as well as of the centennial of their physics building. As part of the festivities, APS presented a plaque commemorating CWRU as a historic physics site, in honor of the Michelson-Morley experiment that took place there in 1887. On hand to present the plaque was then APS vice-President (now President-elect) Leo Kadanoff of the University of Chicago. In the photograph at left, CWRU physics department Chair Cyrus Taylor holds the plaque, while CWRU trustee emerita Dorothy Hamel Hovorka and Kadanoff look on. The photograph at right shows Kadanoff making the official presentation.

This event was the second such presentation to take place as part of the APS Historic Sites initiative. In July, a plaque was presented to the Franklin Institute in Philadelphia in honor of the scientific work of Benjamin Franklin (see APS News, October 2005).

Members in the Media

"Frequently, brains would win the day. You had to outthink your opponent, so it always reinforced to me as a kid that being smart was a positive, that it was a superpower in a way. And there are superheroes where their superpower is intelligence."

–Jim Kakalios, University of Minnesota, on his book on the physics of superheroes, the Star Tribune, (Minneapolis) November 11, 2005

"The morale here is abysmal. People's lives have been wrenched apart by the political games that have been played. You can't hold people's careers by the heels out over the balcony without them feeling threatened and cheapened."

–Brad Lee Holian, Los Alamos National Lab, on morale at LANL, San Francisco Chronicle, November 17, 2005

"People ask, 'Why bacteria?' And the reason is very simple. It has to do with the fact that bacteria are the most fundamental organism. So if we want to understand the differences between animate and not-animate matter then ... we want to consider the bacteria, because they are the first organism, the first transition from nonliving to living cells."

–Eshel Ben-Jacob, Tel Aviv University, on why he studies bacteria, The Post and Courier, Charleston, SC, November 28, 2005

"There's a feeling that we could find a way to really use solar energy on a large scale within 10 to 15 years. The scientists are really jazzed up about this. It really does take a state-of-the-art science and apply it to a world problem that really matters. There's a lot of energy and idealism."

–Paul Alivisatos, UC Berkeley, on applying nanotechnology to solar energy, San Mateo Times, November 28, 2005

"If we don't fix things, we'll slide right into Third World status. But the problem is soluble. I'm a physicist, and physicists have to be optimistic, otherwise we'd never try to understand the nature of dark energy."

–Leon Lederman, Fermilab, on the state of science education, Chicago Tribune, November 19, 2005

"It's craziness. What's in this package actually makes the waste problem worse unless you invest huge amounts in recycling this stuff. This would increase the amount of nuclear-weapons materials loose in the world, and that's the last thing we need right now."

–Frank von Hippel, Princeton University, on a proposal for reprocessing nuclear fuel, The Tri-Valley Herald, November 21, 2005

"We want to understand how nature reaches these energies. The energies of the particles that we'll be observing with this detector are millions of times more powerful than we can produce with particle accelerators on Earth. In principle these particles will give us the possibility of testing physics that we can't test in our laboratories. What happened at the beginning of the universe is the same that you could try to probe by reaching higher and higher energies."

–Angela Olinto, University of Chicago, on a new cosmic ray detector in Argentina, Chicago Tribune, November 9, 2005

"What COBE told us, once and for all, was that the theory behind the big bang was right after all."

–John C. Mather, NASA, the Baltimore Sun, November 11, 2005

"That's got to be tough out in the heat and dirt. That or some sort of forensic job would be unpleasant. Trying to understand how somebody was killed. That's yucky stuff."

–Thomas Sanford, Sandia National Labs, on fossil hunting in hot weather and forensic work, which he thinks would be some of the worst jobs in science, Albuquerque Tribune, November 17, 2005

"In today's world, you will either be a nerd or end up working for a nerd."

–Vernon Ehlers, US House of Representatives, on why we should teach kids to be nerds, the Grand Rapids Press, November 22, 2005

"I'm betting that we just haven't yet gotten the full view of the story. Once we start getting these really high-quality data coming in, more and more of it, I'm really hoping that somebody steps way back and says 'Oh, we were just looking at it the wrong way,' and it'll turn out not to be a dark energy. It'll turn out to be some other way of just

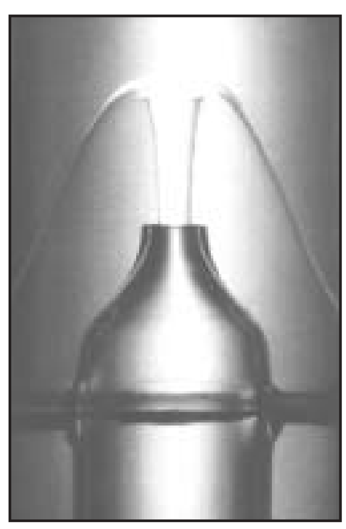
Members in the Media contiued on page 7

This Month in Physics History

January 1938: Discovery of Superfluidity

When helium-4 is chilled to below about 2.2 K, it starts to behave in some very weird ways. The fluid passes through narrow tubes with almost no friction, and even climbs up walls and overflows its container. Though there were early suggestions of odd behavior, it took 30 years after helium had been liquefied before its superfluidity was discovered.

In 1908, Heike Kamerlingh Onnes first liquefied helium at the University of Leiden in the Netherlands. Soon there were several hints at the strange behavior of liquid helium. By 1924 Onnes had made precise measurements of liquid helium's density, and found that as the temperature lowers, the density goes through a sharp maximum at about 2.2 K. In 1927 Willem Keesom and Mieczyslaw Wolfke concluded that that liquid helium undergoes a phase transition at about 2.2 K. This temperature is called the lambda point because the graph of specific heat versus temperature resembles the Greek letter lambda. The two phases are called helium I and helium II.



A superfluid helium fountain

Though these were interesting results, they were not so surprising that anyone paid much attention at the time. The truly remarkable result, that helium II is a superfluid, was first discovered in 1937 and published in January 1938, by Pyotr Kapitsa in Moscow, and independently by John F. Allen and Donald Misener at the University of Toronto.

Kapitsa, the son of a military engineer, was born in 1894 in Kronstadt, near Leningrad. He studied engineering at Petrograd Polytechnical Institute, graduated in 1918, and stayed on as a lecturer there for several years, during which time he carried out research on magnetic fields.

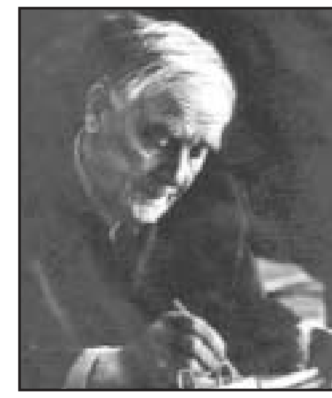
After losing his first wife and two young children to an influenza epidemic in 1921, Kapitsa moved to Cambridge to work with Ernest Rutherford at the Cavendish Laboratory. Kapitsa first worked on magnetic field research, developing ways to produce extremely strong magnetic fields. After several years he turned his attention to low temperature research, and in 1934 he developed a new method for liquefying large amounts of helium, which paved the way for continued experiments with the strange fluid.

In 1934, Kapitsa traveled to Russia on a visit, expecting to return to Cambridge. For reasons that are not clear, he was detained and had his passport seized on Stalin's orders. When it became clear that Kapitsa could not return to Cambridge, Rutherford helped arrange for most of his apparatus from his lab at Cambridge to be sent to him, and Kapitsa set up a new research facility, the Institute of Physical Problems, in Moscow.

In 1937, while investigating the thermal conductivity of liquid helium, Kapitsa measured the flow as the fluid flows through a gap between two discs into a surrounding bath.

The results were striking: above the lambda point, there was little flow, but below the lambda temperature, the liquid flowed with such great ease that Kapitsa drew an analogy with superconductors, and wrote in his paper in *Nature* on January 8, 1938 "the helium below the lambda point enters a special state that might be called a 'superfluid'."

At the same time, Allen and Misener at the University of Toronto performed similar studies on liquid helium, using a slightly different setup. They measured the flow through a narrow glass tube, and also observed the extremely low viscosity. They noted that the flow was almost independent of pressure and that therefore "any known formula cannot, from our data, give a value of viscosity which would have any meaning." Their paper appeared in *Nature* back-to-back with Kapitsa's article.



Pyotr Kapitsa

It is now understood that helium II can be described as a two-fluid mixture–part a normal fluid, and part a superfluid, in which atoms have condensed into a single quantum state. This two fluid model explains Kapitsa's and Allen and Misener's results.

Kapitsa continued his research in low temperature physics for several years. During World War II he built an apparatus for producing large amounts of liquid oxygen for the soviet steel industry. In the 1940s he turned his attention to plasma physics and fusion. In 1946 he refused to work on the Soviet atomic bomb, and thus fell out of favor with Stalin. He lost his position at the Institute of Physical Problems, and was not reinstated until after Stalin's death.

Thirty years after his discovery of superfluidity, and long after he had moved on to other research topics, Kapitsa was awarded the Nobel Prize in Physics for his low temperature research. He shared the 1978 prize with Arno Penzias and Robert Wilson, who won for their discovery of the cosmic microwave background radiation.

Allen and Misener, though they made essentially the same discovery as Kapitsa, did not receive a Nobel Prize, and Kapitsa is generally the one credited with the discovery of superfluidity.

The work on liquid helium and the understanding of the weird properties of the superfluid state have been fundamental to the field of low temperature physics, which is still an exciting area of research today, as ever more exotic low temperature states continue to be produced.

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New APS President Highlights Research Funding, Upcoming Changes in APS Personnel

John Hopfield (Princeton University) assumed the APS presidency on January 1, 2006. In the following interview with APS News, he discusses his priorities for the Society during his presidential year.

Q: What do you see as some of the most important issues facing the physics community today, and how can the APS address some of these issues?

A: I think the most important things are the level of support for research in the United States, both at a federal level and in industrial labs, and the level of support for education in the physical sciences and math. Both of these have bit by bit become disaster areas. There's a recent National Academy of Sciences report on ensuring America's economic future in the global economy. The report outlines recommendations for improving education in science and math and increasing investment in research in the physical sciences, in order to ensure US competitiveness and innovation.

I think one of the most important things for the APS in the next year is working with other societies and groups to help be sure that appropriate legislation gets formed to meet some of the goals of that report. I think there's a real opportunity there, and I think to miss this opportunity will be to enlist in a slow progress to a disaster. APS has the Office of Public Affairs and the Physics Policy Committee. There are people in these who have enough visibility, enough status with respect to the government, and who aren't highly politically polarizing. I think this kind of representation puts the APS in a position to influence the right bureaucratic and legislative corners in Washington, to try to get legislation written. These issues must to be brought to the administration's attention. While the NAS authorship and the membership of the report committee give strong credibility to the report, the NAS is not in a position to push for its implementation.

Q: What do you plan to focus on during your term as APS president?

A: When I look at the APS, I see that it's in very good shape. There's been excellent continuity over the years. However, a year from now there's going to be a new Treasurer and a new Editor-in-Chief. That's two of the triumvirate of three that really run the APS. The people who are leaving these positions have been very effective. As far as I'm concerned, this year for the APS has got to be one of successful transition wherein the people who are taking over those positions are brought into the loop. They must become participants early enough that they have a chance to learn from Tom McIlrath and Marty Blume. It has to be a smooth transition. 2007 will undoubtedly begin a new era, but the transition has to be adiabatic. That's probably the most important challenge for the next year. It takes precedence over any particular pet project I might otherwise have had.

Q: As science becomes increasingly interdisciplinary, how can APS be as inclusive as possible? You work in a biology department. Does that give you a different perspective on the interdisciplinary nature of the field?

A: I will be the first president of APS who has been so far outside the fields of physics that have traditionally been viewed as hard-core physics. I was in the Princeton Physics Department from 1964 until 1980, then went to Caltech in Chemistry and Biology, and came back to Princeton in Biology in 1996. I would contend that I have been doing physics the entire time. It's only that I went from the physics of condensed matter to the physics of biological matter and biological systems. Understanding the dynamical relationship between structure and properties, at an appropriate scale of resolution, is central to both. Physics is changing. Physics departments understand that they face the choice between keeping a broad definition of physics and keeping broad student interest, and having narrow definitions of physics and facing declining student interest and declining public interest and support. I think as a whole that physics is making the choice for breadth. If I look at physics majors leaving good departments, 30 years ago they largely went on in physics departments, but many of them now go to departments or jobs that are at the fringe of physics. That's splendid for physics as a whole, as long as we run meetings where these people continue to be involved. I think that keeping up the breadth of the meetings is the biggest issue there.

Q: How does physics education need to change to better prepare students and keep them interested in physics?

A: At most institutions, physics education has changed lamentably little since 1950. Look at freshman physics. The old course was an appropriate course for potential physics majors, and for some engineers. It emphasized Newton's laws and Maxwell's equations. But it contained little thermal physics, and minimal discussions of physics at the microscopic scale, of chemistry, of molecules. I think the emphasis has not remained very well balanced with respect to a changing clientele. With the interest there is now in biology, condensed matter physics, and physics as the basis for other technologies (e.g. nanotechnology), I think a reordering of content and courses of a physics education is very much needed at most institutions.

Q: Science is a very international enterprise. Are there ways APS can better serve its international members and promote international collaboration and information exchange?

A: Anything that takes place electronically is going ever faster. The rate of exchange of information is almost not a limiting factor any longer. At the same time, the fact that everybody relies on the web and e-mail for exchange of information cuts down on true personal contact.

The APS is, by origin, the American Physical Society. But for many it is The Physical Society. It's American in location, and in its lobbying activities, but not particularly in any other way or spirit. But because we don't have very much support for individuals to go to meetings, there have been few ways for the APS to promote international contact. There is a small but active Office of International Affairs with a variety of activities, and APS involvement in a conference on physics and sustainable development, held in South Africa, was but one of many activities of that office. Historically, using the physics community to build bridges between the US and countries with which our political contact is belligerent has been very stabilizing to the international scene, and the APS should be alert to such possibilities.

Q: The *Physical Review* Journals are one of the major things APS does. How do you view the journals as publishing continues to become increasingly electronic and the journals face more competition?

A: APS journals have been going electronic at a marvelous pace–we have been leaders in getting our information online. One of the phenomena associated with everything going electronic is that the importance of a journal as such drops when I am reading for science information. I seldom have a journal volume in my hands. The question of what things are bound together in a particular volume, between covers with a particular title, seldom enters my head when I am reading research. The individual article, not the journal, is fast becoming the unit of selection by a reader. However, the journal in which an article is published tends to become a surrogate for the quality of an article when evaluating the scientific contributions of someone outside of your own research area. For that reason, authors will continue to compete to have their articles published in quality journals. It's very important that the refereeing process, however it is done, results in articles that readers find important and of outstanding quality. We have a marvelous record in that regard, but it's important that we keep it up in a rapidly changing publishing environment. I think it's going to be very important for the next Editor-in-Chief to be somebody who focuses on where information dissemination is going, and is not too heavily tied to our admittedly glorious past, or even present.

Q: What can we do in 2006, now that the World Year of Physics is over, to keep up the enthusiasm?

A: That's an interesting question–we ought to learn from the experience of the 2005 Year. 2005 became so much the World Year of Einstein that it lost some aspect of the World Year of Physics. I think as we try to keep physics in the newspapers, to keep physics in

New APS President continued on page 6

John J. Hopfield

2nd Successful Joint DNP/JPS Meeting Held in Hawaii

Scientists reported the latest results on experiments exploring the quark–gluon plasma at Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC) at the 2005 fall meeting of the APS Division of Nuclear Physics (DNP), held in conjunction with the Japanese Physical Society (JPS), September 18-22, on the island of Maui in Hawaii. Other technical highlights included research into unstable nuclei and supernova core collapse, homeland security screening applications, semiconductor failure analysis, and setting priorities for the future of nuclear physics.

It was second joint meeting between the DNP and the JPS, both of them organized in the hopes that such conferences would serve as a meeting ground to engender cooperation and the exchange of ideas among nuclear scientists from the US and Japan, as well as from other Pacific Rim countries. The first joint meeting, held in 2001, was a resounding success, with more than 800 participants in attendance. The 2005 meeting was even more successful, with more than 900 attendees, a third of them from Japan.

Saturday, September 17th, featured a special "Physics Fun Day" at the Queen Ka'ahumanu Shopping Center as part of the year-long World Year of Physics celebration. There were hands-on science activities for adults and children of all ages, as well as a Physics Olympics targeting middle and high school students, and a resource table for physics teachers. In addition, Lawrence Krauss, a professor at Case Western Reserve University and author of the bestselling *The Physics of Star Trek*, gave a free public lecture at the Maui Arts and Cultural Center on "Einstein's Biggest Blunder: A Cosmic Mystery."

Mind Your QGPs. Last year, Brookhaven scientists made the surprising announcement that they had observed evidence of the strongly-coupled quark-gluon plasma (QGP) in nucleus-nucleus collisions at RHIC, although its exact nature isn't quite what physicists expected: it appears to be a quark-gluon liquid. Several scientists presented results from the most recent experiments seeking to characterize the bulk properties and dynamical evolution of this unique phase of matter, among them Duke University's Steffan Bass. RIKEN's Yasuyuki Akiba reviewed the latest measurements of heavy quarks (charm and beauty) at RHIC, which should shed even more light on the QGP's properties.

RIKEN Upgrades. At the RIKEN facility in Japan, beams of unstable nuclei (called radioactive isotope, or RI, beams) have been used to uncover many new nuclear properties and insights into nuclear structure. RIKEN's Tohru Motobayashi summarized achievements to date and outlined plans for a new project, the RI Beam Factory (RIBF) at RIKEN, which is now under construction and expected to come online in 2006. RIBF will provide a much wider range of RI beams with higher intensities than the present facility.

Collapsing Supernovae. The RI beams at the RIKEN facility have also been used to study nuclear burning processes involving unstable nuclei, which appear to play a critical role in the explosion mechanism of core-collapse supernovae–and hence in the nucleosynthesis of all the heavy elements in the cosmos. Kohsuke Sumiyoshi of Japan's National Astronomical Observatory has found that the nuclear reactions of neutron-rich nuclei play crucial roles in some nucleosynthesis processes.

Gail McLaughlin of North Carolina State University followed Sumiyoshi. While astrophysicists have understood the mechanism for producing the heaviest elements for half a century, "the astrophysical site remains a mystery," she said. Possibilities include the neutrino-driven wind of Type II supernovae and the outflow from accretion disks surrounding black holes. Such disks tend to form when neutron stars merge, or when rapidly rotating massive stars collapse. Both scenarios result in a significant flux of neutrinos, which can then impact the neutron-to-proton ratio and thus the process of nucleosynthesis.

Helping Secure the Homeland. Scientists at Lawrence Livermore National Laboratory are developing a new system to reduce the likelihood of false negative and false positive detections of fissile material in ship cargo.

DNP Meeting continued on page 5

Letters

Too Much Screaming, Not Enough Debate on Evolution

Intelligent Design is not the draconian threat envisioned by back page author Marshall Berman [*APS News*, October 2005]. Nearly everything about this controversy has been blown way out of proportion. The central problem is that extremely polarized factions have made it the centerpiece of the fight between atheism and religious fundamentalism. There has been no opportunity for voices of moderation to be heard above the screaming.

Instead of the extremists on either end, there are two significant scientists who are party to the intelligent design controversy, and thoughtful people would do much better to pay attention to them:

One is Michael Behe from Lehigh University, who wrote a book "Darwin's Black Box" in which he made specific and limited criticisms of Darwinian evolution. For over a decade, Behe has resisted the role of "champion" that the Creationists would like to thrust upon him; he has made NO statement supporting creationism, but steadfastly insisted that Darwin's theory is missing something.

The other is Kenneth Miller of Brown University, author of "Finding Darwin's God," and also author of a leading high school biology text. Miller carefully distinguishes between science on one hand and philosophy on the other, and judges that Intelligent Design Theory falls in the realm of philosophy. Somewhat similar to Behe, Miller has resisted the blandishments of the scientific materialists who would make him their hero. He doesn't dislike philosophy or theology, but he insists that the borderline with science should be acknowledged and respected.

If you think back a few centuries, there really was a time when phlogiston was taken as scientific fact; and when the concept was later overthrown, it did not cause the collapse of all Newtonian Mechanics–only a correction; and then science moved forward again. When someone today points out that Darwinism can't account for everything, but that person cannot provide a complete alternative explanation, you would think that people would start looking for a correction. Unfortunately, the extreme polarization surrounding the argument has made that nearly impossible, and people are presumed to take sides. The prevailing scientific establishment brands as a "religious nut" anyone who doesn't totally accept the scientific materialist's viewpoint that neo-Darwinian evolution can explain everything about life.

If the screamers would kindly get off the stage, a coherent (and ultimately useful) debate could begin. Two cornerstones of that debate would be to notice the incompleteness of Darwin's theory, and to distinguish between the domain of science and the domain of philosophy. These are the two strongest points made by Behe and Miller. I think that if such a debate were pursued, evolution would win, but it would be sobered by the insights of intelligent design theory, and we would all end up knowing more about life processes.

Marshall Berman's headline begins "Intelligent Design: The New Creationism...", but the colon is really an equal sign. When he first conflates intelligent design with

Too Much Screaming continued on page 7

There Is No Joy in Physics

Re: Intelligent Design: The New Creationism Threatens All of Science and Society, by Marshall Berman, *APS News* Back Page, October, 2005:

I do not believe that "The ID movement poses a threat to all science and perhaps secular democracy itself." Berman's radical and narrow-minded rhetoric adds nothing of value to the discussion of "Evolution" and adds to the confusion about what the discussion should be about. The best measured and reasonable perspective I have found on this has been given by Freeman J. Dyson in *Infinite in All Directions* (Harper & Row, New York (1985)). Dyson states, "In the no-man's land between science and theology, there are five specific points at which faith and reason may appear to clash. The five points are the origin of life, the human experience of free will, the prohibition of teleological explanations in science, the argument from design as an explanatory principle, and the question of ultimate aims." I fail to see how any serious scientist can disagree with this assessment.

It does not help for leaders in the fields of science to just brand the ID advocates as fools, in the "dark ages", and a "threat." There are obviously missing links in the "Theory of Evolution." I believe with Dyson that the argument from design has merit as a philosophical principle. One argument centers on the accidental nature of evolution. Accidental mutations followed by natural selection are sometimes claimed to explain everything. I believe it was Eugene Wigner who said, "Where in the Schroedinger equation do you put the joy of being alive?" Evolution fails to explain the role of mind and consciousness in human affairs, among other things.

The arguments of "Creation Science" may be overstated; so is Berman's case. Can we hear a more rational discussion?

Fletcher Gabbard
McKee, KY

Start Spreadin' the News

I sincerely believe that it would be beneficial to society to get the "Intelligent Design" Back Page in the October *APS News* published in mainstream newspapers and media.

The deceptions and lies of the Discovery Institute must be revealed to the general public!

Brad Barker
Port St Lucie, FL

Viewpoint...

Dr. Atomic Offers Lessons on the Pros and Cons of Public Outreach

By Marvin L. Cohen

The World Year of Physics (WYP) in 2005 meant a year of outreach for the APS and its officers. I traveled around the world, showed the Einstein poster in every talk I gave, and urged those I met with the same line: "This is the World Year of Physics; take a physicist to lunch." I lauded our field every chance I got, and even snagged a few free lunches in the process.

Even before the WYP kicked into high gear, I was already deep into "physics outreach mode." In October 2004, Alexander (Sandy) Fetter from Stanford University contacted me. Sandy said he knew the development officer working with Pamela Rosenberg, the executive director of the San Francisco Opera (SFO), who wanted [former APS president] Helen Quinn and me to learn about the SFO's future production of a newly commissioned opera, *Doctor Atomic*. The SFO hoped to get some type of endorsement of the opera from the APS.

We attended a workshop during which an excerpt of the opera was performed on October 30. This is when I first heard the opening lines:

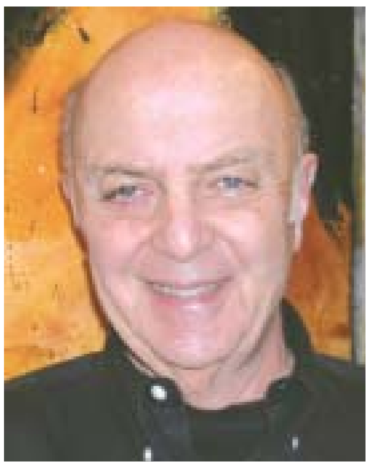
Matter can neither be created nor destroyed, but only altered in form
Energy can be neither created nor destroyed, but only altered in form.

When the performance of the excerpt ended, my hand flew up immediately. I stated that 2005 had been designated the WYP celebrating the 100th anniversary of Einstein's year of great discoveries, including his equation, $E=mc^2$. I emphasized that this equation shows that matter can be changed into energy. More importantly, considering the opera's theme, that's how you make an atomic bomb. You destroy a little bit of matter and turn it into a huge amount of energy.

The opening lines of the opera are from the 1945 "Smyth Report," which goes on to make exactly the same point about $E=mc^2$, but in the opera, the quote was incomplete. I naively assumed that composer John Adams and director/librettist Peter Sellars would change the offending lines. It's one of the characteristics of being a professor: you assume people are listening to you, and that they will react appropriately when corrected.

At the next APS Executive Board meeting, I raised the question of acknowledging *Dr. Atomic* in some way. Since the APS endorses conferences but not works of art, we decided to pass the following resolution: "The American Physical Society recognizes the importance of the Manhattan Project in our history and endorses the creative role of the arts in helping the public to understand it." Some Board members expressed worries about what message the opera would convey about physicists and their ethics. I was worried about energy and matter and the possibility of other technical mistakes I hadn't seen yet. I was not comforted by the advertisements for the opera promising that it would be based on historical documents.

Unfortunately, no changes were made. I finally got the libretto in its entirety, reviewed government documents that had been used to create the opera, and met with SFO officers. Except for the opening, the libretto was technically acceptable. I had the audacity to suggest adding a line to the opening to make everything technically acceptable. I received a copy of the score with my line in it, but at one of the final rehearsals it was decided that the line didn't make it musically. I



Marvin Cohen

missed my only chance to be part of an opera. They went ahead with the old version and inserted a quote from me in the opera program stating "the problem."

Just prior to the opening, I participated in a panel on the University of California, Berkeley campus with Adams, Sellars, and our Dean of Physical Sciences, Mark Richards. There was an overflowing crowd in a large lecture hall. Even the opera itself seemed insignificant when I played the first part of a tape of a talk Oppenheimer gave in Philadelphia on November 16, 1945, four months after Trinity. This tape was recently discovered in the archives of the American Philosophical Society. Oppenheimer gives a chilling account of what happened in Hiroshima and Nagasaki, and he goes on to give his view of what the future will bring. It drove home the point that the making of the bomb is a milestone in history.

The tape also allowed me to make the point that scientists were willing to join the Manhattan Project because they thought that the German scientists might get there first. Some were refugees who escaped from Europe and wanted to drop the bomb on Hitler. However after Trinity and the German surrender, scientists were divided about the question of whether to drop the bomb on Japan. This debate goes on today after 60 years.

I saw the opera twice. I liked it. I particularly liked the music, although I wish there had been another act focusing on the Oppenheimer security clearance affair. This would have made the opera more about Oppenheimer than about the bomb. It would have been the modern Faust theme that Pamela Rosenberg wanted when she commissioned the opera. Adams had rejected the Faust connection early on. Above all, I was greatly impressed by the public interest created by the opera not only in Oppenheimer and the bomb, but in physicists and the ethical questions we sometimes face.

Regarding my own involvement, I didn't like the position in which I found myself, *vis a vis* the libretto. I was reminded of the famous story of the Austrian emperor telling Mozart that his opera had too many notes, and Mozart's retort that, on the contrary, it had "just the right number of notes." I never thought I'd be on the other side. I always identified with Mozart.

Marvin Cohen is APS past president.

Teach Intelligent Design as an Example of Non-Science

Marshall Berman warns of the dangers of the "Intelligent Design" movement (*APS News*, October), but one common reaction of scientists–to ban all discussion of Intelligent Design from science classes–is misplaced. Far better to meet the challenge head on. A brief description of the Intelligent Design concept should be given, noting that it rests entirely on claims that there are gaps in the description of life given by Darwinian evolution. In effect, it is only a critique of Darwinism; it offers no evidence for its validity beyond the assertion that evolutionary theory has not yet answered every question concerning the complexity of life.

It is only fair, then, that any discussion of Intelligent Design should also include a critique of it. First, the many ways in which the supposed inadequacies of Darwinism have been exaggerated should be noted. Second, note the many questions Intelligent Design cannot even pretend to answer: why do many organisms possess vestigial organs that no longer provide useful function; e.g., the human appendix? What kind of Intelligent Design is it that allows some of its highest creations (including humans) to be slaughtered by the uncontrolled proliferation of its own cells (i.e., cancer) or by the most incomplete of living forms (i.e., viruses)? How to explain evolution we see occurring before our very eyes (e.g., disease microbes developing resistance to drugs)?

Third, and most importantly, Intelligent Design lacks the fundamental epistemology of any scientific theory: it is neither verifiable nor falsifiable by any experimental observations. It makes no predictions as to what should be observed in circumstances not yet studied, and thus no observational result can either strengthen or weaken the evidence for or against Intelligent Design. It therefore lacks this most fundamental attribute of a scientific theory.

An hour or two spent discussing Intelligent Design in this way would provide students with a much better idea as to why scientists do not accept it as a legitimate scientific competitor to Darwinian evolution than does simply refusing to discuss the subject.

David C. Williams
Albuquerque, NM

Senators Express Concern Over Layoffs and Run Times at RHIC and Jefferson Lab

Before the Senate passed the FY 2006 Energy and Water Development Appropriations Bill in November, senators discussed the negative impacts that a reduction in funding for the Department of Energy's (DOE) Nuclear Physics program will have on two key facilities. As it now stands, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory and the Thomas Jefferson National Accelerator Facility will have to reduce operating times, and, at least at RHIC, reduce staffing.

When the Bush Administration sent its FY 2006 budget request to Congress, it sought an 8.4% reduction in the Nuclear Physics program budget, from $404.8 million to $370.7 million. The Administration acknowledged this cut would result in a 29% reduction in run time at the Jefferson Accelerator Facility and a 61% reduction in run time at RHIC.

Going into the conference to settle on the final version of the FY 2006 bill, it appeared that the Administration's suggested cut in the Nuclear Physics program budget would be rejected. The House's initial version of the bill had recommended FY 2006 funding a bit higher than what was then the current level. The Senate bill came in even higher, at almost $420 million. A DOE senior official called the outlook "very encouraging" at a meeting of the DOE/NSF Nuclear Science Advisory Committee in early September.

Despite this promising outlook, the final appropriations bill funded the Nuclear Physics program at the level requested by the Administration, cutting the budget by 8.4% to $370.7 million.

Laboratory officials are still grappling with the projected impacts of the reduced budget. RHIC's next scheduled run has been delayed until late in FY 2006. It will be combined with the run for 2007 to afford the longest possible time for experimentation. Brookhaven's current hiring freeze will be extended, and officials estimate there could be as many as 100 scientific and support position layoffs between now and next October 1.

There is language in the FY 2006 Energy and Water Development Appropriations bill allowing DOE to reprogram, or shift, money from one program to another, as confirmed in a discussion that took place on the Senate floor. Senator Hillary Rodham Clinton (D-NY) led the November 14 discussion, highlighting the severe impacts of the reduced funding levels. She was joined by Senator John Warner (R-VA), who expressed concern about the reduced funding level, stating, "At the Jefferson Lab we need to invest in the 12GeV upgrade necessary to sustain the pace of scientific discovery, not cut programs." Senator Charles Schumer (D-NY) and Senator George Allen (R-VA) expressed similar concerns.

Courtesy of FYI, the American Institute of Physics Bulletin of Science Policy News (http://aip.org/fyi).

DNP MEETING CONTINUED FROM PAGE 3

Approximately 6 million cargo containers arrive at US seaports annually, carrying up to 30 tons of non-homogenous cargo on each one, according to LLNL's Jennifer Church. It is extremely difficult to detect highly enriched uranium and other nuclear material concealed within such containers using existing monitors, partly because of extreme attenuation of low energy gamma rays in the cargo. The new technique uses a neutron beam to induce fission, combining it with a wall of plastic scintillators to detect delayed high energy gamma rays after beta decay of the fission products.

Meanwhile, in Japan, researchers have used the detection system of near-horizontal cosmic-ray muon radiography equipment–originally developed for probing volcanic mountains–to probe the inner structure of a blast furnace. They measured the thickness of the brickwork to glean critical information to predict the lifetime of the furnace. Future work will focus on extending the muon radiography method to detect selected elements of concealed nuclear materials using a compact accelerator system.

Neutrons' Failing Grades. Neutron-induced failures in semiconductor devices are of increasing concern to the industry. Neutron interactions in semiconductor devices produce ionized recoils or reaction products, thereby depositing charge and causing various common failures, according to S.A. Wender of the Los Alamos Neutron Science Center (LANSCE). Predicting the failure rate depends on knowing the neutron flux in the environment of a particular device, as well as how various devices respond to neutrons.

Council Passes Memorial Resolution for John Bahcall

APS President-elect John Bahcall died in August (see *APS News*, October 2005), and at its meeting in November, Council passed a resolution in his memory. The text of the resolution follows.

The Council of the American Physical Society notes with great sadness the death of John Bahcall of the Institute for Advanced Study. He was elected APS Vice President in 2003 with the expectation that he would become President in 2006, but in early 2005 he recognized that he would be unable to continue to serve. He was a leader in many areas of astrophysics: providing models for the sun and the neutrino flux from it, for the structure of galaxies, and for quasars and the intergalactic medium. In addition he played a leadership role in promoting significant astrophysical projects such as the Hubble Space Telescope. Among his many awards are the Wolf Prize, the National Medal of Science, and the APS Hans Bethe Prize. The Council expresses its deep appreciation for his participation in the work of the Society and conveys its sincere sympathy to his family and to his many close friends and admirers worldwide.

The Mandelbrot Set

Photo credit: Darlene Logan

Benoît Mandelbrot (left) of IBM and Yale joined other APS Fellows at a reception at the Princeton Club in New York City on November 30. The members of his set included Norton Lang of IBM (center) and Brian Schwartz of the City University of New York (right). In the background is Donald Monroe. In addition to enjoying refreshments and the festive ambience of the Princeton Club, which was decked out for the holiday season, the assembled group of about 80 Fellows heard from APS President-elect (now President) John Hopfield of Princeton, Editor-in-Chief Martin Blume, Treasurer Thomas McIlrath, Director of Education Ted Hodapp, Director of International Affairs Amy Flatten, and Director of Public Affairs Michael Lubell.

SESAPS Holds Annual Fall Meeting

The Southeastern Section of the APS (SESAPS) held its annual fall meeting November 10-12, 2005. The conference was hosted by the University of Florida, Gainsville, with a technical program that ran the gamut of cutting-edge topics in physics: particle physics, dark matter and dark energy, physics history, nanophysics, Bose-Einstein condensates and atomic/molecular optics.

Among the invited lectures in particle physics were reports on the current status of particle searches at Stanford University's B factories, with the aim of gaining a better understanding of CP violation. Other talks focused on recent results from the CDF and D0 experiments at Fermilab, as well as progress on the Large Hadron Collider.

In the area of astrophysics, invited speakers discussed ongoing experiments to explore the cosmic microwave background radiation, as well as the search for gravitational waves–specifically, plans for the upcoming LISA mission. As for optics, attendees were treated to the latest research involving slow-light nonlinear optics with cold atoms, as well as the use of novel light traps to study ultra-cold atoms.

The World Year of Physics figured prominently in the physics history session. Speakers recapped Einstein's years in Switzerland, Max Planck's early contributions to the theory of special relativity, and Sir Arthur Eddington's historic 1919 expeditions that resulted in the verification of general relativity. Friday evening's banquet speaker was Louis Bloomfield, a professor of physics at the University of Virginia, and the author of *How Things Work: The Physics of Everyday Life.*

DFD MEETING CONTINUED FROM PAGE 1

dynamics of the dolphin kick in competitive swimming: a stroke that is performed underwater after starts and turns, involving an undulatory motion of the body. A second team of GWU researchers–working in conjunction with scientists at IBM's T.J. Watson Research Center–conducted highly detailed laser body scans of elite competitive swimmers, and recreated the kinematics of the dolphin kicks from videos of Olympic-level athletes. This work provided the scientists with the first glimpse of the fluid and vortex dynamics associated with the stroke.

Cover Your Mouth. Diseases ranging from the common cold to more lethal conditions like SARS are spread by cough-generated infectious aerosols, so understanding the range and behavior of such flows could help mitigate future outbreaks. To that end, researchers at the University of Colorado at Boulder used particle image velocimetry (PIV) to measure the velocity field of a human cough. They found that cough flow exhibits slow growth–maximum speeds ranged from 1.5 m/s to 28.8 m/s–indicating that a cough may penetrate farther into a room than a steady jet of similar volume.

Small-Scale Flows. As computers, electronic devices, microfluidic labs-on-a-chip, and other key technologies become smaller and smaller, scientists are seeking better understanding of the behavior of gaseous flows at the micro- and nano-size scales, where the traditional Navier-Stokes descriptions break down. MIT's Nicolas Hadjiconstantinou suggests that gaseous hydrodynamics at these scales can be described by the Boltzmann equation. He described some basic results from an asymptotic analysis of that equation, which he has used to resolve a number of open questions in this area, including second-order slip, and a means of reconciling experimental measurements of slipping flows with theory.

The Fluid Mechanics of Fire. Howard Baum of the National Institute of Standards and Technologies illustrated his latest simulation work on fire dynamics in enclosures with the latest results from the NIST investigation of the collapse of the World Trade Center towers, as part of a broader discussion on the fluid mechanics of fires. His talk also covered the role of fire plumes in the transport of heat and mass. Specifically, the plume provides the feedback mechanisms that determine the strength of a fire, and also acts as a pump, mixing the fuel and oxidizer.

EXECUTIVE BOARD CONTINUED FROM PAGE 1

plans to lay off 40 members of its staff and reduce operations by 25 percent.

It is also very likely that DOE's Office of Science will have to consider reducing operations at all four of the Department's X-Ray synchrotron light sources–which are fully subscribed by industrial and university researchers in many scientific fields, including medicine–and will have to defer plans for upgrading Brookhaven's National Synchrotron Light Source, a facility that will soon become non-competitive with new European X-Ray laboratories nearing completion.

In the opinion of the APS Executive Board, H.R. 2419 sets our nation on a course that, if sustained, will soon place us at a competitive disadvantage in science, technology, innovation and global trade. The Board is especially concerned that Congress set the nation on this course at the same time it increased earmarks for Members' special projects by more than 60 percent from FY 2005 to $130 million. The Board calls on Congress to assess the damage H.R. 2419 will do to our science programs and the development of our high-tech workforce. The Board urges Congress to rearrange its priorities next year before the damage becomes irreparable.

zero gravity
The Lighter Side of Science

A Ridiculously Short History of Time

By Eric Oehler

The Big Bang. This great primordial explosion supposedly brought everything in the universe into being, although why exactly it did this remains slightly ambiguous. There was belief that the universe was created as a front for the Mafia, although the scientists who developed this theory have mysteriously disappeared.

The "Not-Quite-So-Big-as-the-Big" Bang. Shortly after the Big Bang, at approximately 10^{-57} seconds, some constituents of the early universe became disgruntled with the way things were going and decided to hold their own universe. The result was the "Not-Quite-so-Big-as-the-Big" Bang. The outcome was disappointing. The new bang accomplished very little, and the two-party system of physics failed miserably since a joint decision between the two could never be reached. This bipartisan idea was basically abandoned throughout the universe and eventually faded from science. Remnants can still be seen in American politics.

That Period When Everything Was Still REALLY Hot. During this phase, things were immensely hot, vaguely resembling New Jersey in summertime. Tempers were short and crime rates soared. Free quarks began roaming in gangs of two and three, and consequently matter formed.

The Great Galactic Air Conditioning. The universe finally decided that it was time to install air conditioning. Things cooled slowly at first, as the universe was trying to save money on its electric bills. Things cooled faster later, when the universe got fed up with the heat and cranked the air conditioning up all the way.

Bosons Acquire Mass. As the universe slowly cooled, intermediate vector bosons decided that it was nicer to stay in a comfortable air conditioned universe than to go out outside and exercise. Bosons became the "lazy bum" particles, then the "fat slob" particles, and finally the "weak" particles. Because of their lack of exercise bosons began to gain mass, unlike their energetic spouses the photons. Electromagnetic particles everywhere gave ultimatums: "Either you bosons lose some weight and quit being such pathetic lazy bums, or electromagnetism and the weak force will file for divorce!" This mad scramble to lose mass was just the beginning of:

The Great Boson Diet. With bosons scrambling about desperately trying to lose weight, the universe was a very turbulent place. The big problem was figuring out just how to go about losing mass and just how many calories bosons could burn without endangering their health. Many tried crash diets, but only ended up gaining it all back. Several gave up entirely and went on to curse Oprah Winfrey forever as "fat particles." The final blow came when random particles adhered into the first snack foods. While very primitive, these proto-Twinkies, quasi-DingDongs and meta-Fritos made the Great Boson Diet an abject failure. Electromagnetism and the weak force eventually divorced. The forces still remain friends, however, and can occasionally be seen flirting in Switzerland and Illinois.

The Universe Moves On. Things proceeded in a somewhat normal manner for a while. There were no more turbulent particle relationships, outside of the normal fission and fusion. Stars were born and died, great nebulae spread out into the cosmos, planets formed,

Zero Gravity continued on page 7

Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: FISCAL YEAR 2006 BUDGET

Congress has completed making appropriations for most key science agencies: NSF, NIST, NASA, and the DOE Office of Science. Action on DOD and NIH is expected to be completed before the end of the calendar year. The results as of press time are summarized below. Note that there is a potential for an additional across the board rescission of 2-3% for all Federal agencies in order to pay for hurricane relief.

•The National Science Foundation received a modest 3.3 percent increase for its Fiscal Year (FY06) budget, for a total budget of $5.65 billion. However, the majority of the increase included the transfer of the costly polar icebreaker ships from the Coast Guard.

•The DOE Office of Science suffered a major and unexpected setback during last minute negotiations in the House-Senate Conference. The overall budget increased 1% to $3.63 billion, but virtually all of the increase went to earmarks. Excluding the $130 million in special member projects, the Office of Science budget declined by half a percent, reversing the increases both houses had approved individually. The cuts are expected to fall hardest on university grantees and two nuclear physics laboratories, RHIC and Jefferson Lab. Brookhaven is considering mothballing RHIC for the coming year and laying off 100 or more employees. Jefferson Lab is planning to cut its running time by at least 25 percent, and reducing its staff by as many as 40 people. The light sources and neutron scattering facilities could experience a 10% decrease in staffing levels, 14% in operating hours, and 17% in the number of users.

•NIST received a 5.3% increase over its FY05 budget.

•NASA Science received a slight increase of 0.4% over its FY05 budget.

The Administration has moved a step closer to making final its presidential budget request for FY07 which it will release on February 6, 2006. The President's Office of Management and Budget (OMB) has completed reviewing budget requests it received from the departments and agencies last summer and has passed back to the agencies the White House decisions. Given the extremely tight fiscal climate and political imperatives for reducing both mandatory and discretionary spending, science research funding is expected to be under great pressure.

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ISSUE: COMPETITIVENESS

In October, the National Academies released a report entitled, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," which had been requested by Senators Lamar Alexander (R-TN) and Jeff Bingaman (D-NM) of the Senate Committee on Energy and Natural Resources last summer. Norman Augustine, retired chairman and CEO of Lockheed Martin Corporation, chaired the august committee that produced the report, which urges policy makers to act rapidly to ensure that the United States is not overtaken in the 21st century battle in global competitiveness. The report makes four principle recommendations:

•Increase America's talent pool by vastly improving K-12 science and mathematics education.

•Sustain and strengthen the nation's commitment to long-term basic research.

•Ensure that the United States is the premier place in the world for innovation.

•Develop, recruit, and retain top students, scientists, and engineers from both the United States and abroad.

While the report is one of a dozen recently released reports addressing US competitiveness, it is receiving a great deal of attention from Congress and the Administration because of the prominence of the committee, the timing of the release, and the compelling presentations they've made. The committee included such notables as Craig Barrett, chairman of the board of Intel Corporation; Robert Gates, president of Texas A&M and former Director of the Central Intelligence Agency; Charles Holliday, chairman of the board of Dupont; Lee Raymond, chairman of the board and CEO of Exxon-Mobil; and Roy Vagelos, retired chairman of the board and CEO of Merck. The committee also included university presidents; current and former directors of national laboratories; and three Noble Prize winners. To view the report, go to http://www.nap.edu/catalog/11463.html.

Log on to the APS Web site
(http://www.aps.org/public_affairs) for more information.

NEW APS PRESIDENT CONTINUED FROM PAGE 3

the elementary schools, to keep physics in the public view, and to keep the public interested in supporting us, we've got to do something to make physics more accessible. We have to show that it is not something that only somebody with the genius of Einstein can do well. We need to publicize the breadth over which physicists find significant problems. We have to do something that emphasizes that physics is behind the vast bulk of the technologies that make the world what it is today. We have to emphasize that understanding physics better and more deeply is very important to maintaining the United States position in a technological world, and that an increased popular understanding of physics is important to making political decisions about technology.

Q: How did you become interested in physics?

A: My mother was a physicist and my father was a physicist. I thought that was perfectly ordinary. Interestingly, I didn't learn much about physics from them. What I got, particularly from my father, was the attitude that you ought to be able to look at the world and understand how it works. If something was broken you should be able to fix it. You ought to be able to make measurements, and take it apart into components, and eventually understand how 'it works'. (I of course tried this myself when I was young, abetted by my mother and with results which were later repairable by one parent or the other). It didn't matter to my father whether it was the voltage regulator of the car generator or the spectrum of a molecule, the general view about what a physicist ought to be able to do was a universal to him. To me that attitude became the essence of a physicist. It's not the specific system you are working on, but the attitude you bring, that defines a physicist. You can do good physics whether you're studying quarks or the water drops coming from a faucet. The attitude about what kinds of questions should be asked, and what is meant by an answer--that's what characterizes physics to me. Nothing is a priori out of bounds. There are many significant questions outside of the bounds of physics, but when you run across one, you know it because you are unable to find the kind of answers that are satisfactory to you. For instance, I remember talking with Feynman at one point about consciousness. He had given considerable thought to it over the years, and decided that because he couldn't conceive of how to do objective experiments of relevance to the central issues of consciousness, it lay outside of physics.

Pay Attention or I'll Collapse Your Wavefunction

Photo credit: Ernie Tretkoff

Jennifer Ouellette reads to a stuffed quantum cat.

A new book by *APS News* Associate Editor Jennifer Ouellette has turned the "This Month in Physics History" column into a fun and accessible collection of essays for a general audience. Ouellette's book, *Black Bodies and Quantum Cats*, was released on December 27, published by Penguin Books.

The book began from the history columns written by Ouellette for *APS News*, but the essays in the book have been significantly expanded and written to appeal to a wider readership. Each chapter in *Black Bodies and Quantum Cats* deals with a single theme in science history, from Leonardo da Vinci to string theory. Among the supporting cast of scientifically interesting objects are roller coasters, IBM's chess playing computer, Reddi-whip and Velcro.

The short, self-contained essays explain physics through references to movies, television, literature, and art. Each chapter shows the quirky personalities and amusing stories behind the science. For instance, Eilmer of Malmesbury, a medieval monk who jumped off a roof with a crude pair of wings in 1010, appears in the chapter on flight. A building in Zimbabwe designed to mimic the temperature regulation found in termite mounds illustrates the principle of biomimicry. A chapter on the discovery of the top quark compares the subatomic zoo to the huge and eccentric Greek family in the hit movie *My Big Fat Greek Wedding*.

Black Bodies and Quantum Cats will appeal to anyone who wants to learn more about how some of the most amazing discoveries in science came about. Even physicists should enjoy it.

Ouellette, a big fan of the TV show Buffy the Vampire Slayer, has also just completed a book on the *Physics of the Buffyverse*, which will be published in January 2007.

INTERNATIONAL News

...from the APS Office of International Affairs

High-Tech Growth a Priority in Central and Eastern Europe

George W. Handy

Global competition has placed a premium on growth in science and technology. This is particularly true in Central and Eastern Europe (CEE), where the 10 leading countries* are growing at an average rate of 5.8% of GDP as opposed to a 1.8% rate for the 15 West European countries, called the EU 15. These 10 CEE countries have a tradition of intellectual achievement, and a recognition that sustained economic growth requires improved capacity rather that simply relying on cheap labor. High technology growth has become a priority for these 10 CEE countries, and a basis for their increasing economic cooperation across the Euro-Atlantic community–and globally.

Central and Eastern European countries are particularly aware of American excellence in high technology growth. A number of current initiatives have been organized with an emphasis on sharing American success in innovation, commercialization and in attracting private investment. This is leading to increased CEE joint ventures in high technology with the US and other countries. More can be done.

For the past 13 years, the Center for Strategic and International Studies (CSIS) has offered a program that has addressed opportunities for high technology growth as one of a number of key areas for economic transformation, particularly for the countries of the Former Soviet Union. This program, the International Action Commissions Program, has completed 170 projects that have helped to introduce practical, near-term improvements in business and investment growth as a part of the transformation of these countries. The most recent of seven Action Commissions is the Euro-Atlantic Action Commission, and it focuses on the 10 leading CEE countries identified earlier in this paper. This Action Commission has undertaken projects on high technology growth based in the Czech Republic, Hungary, Poland, Romania and Slovakia. This article draws specifically on these recent hands-on experiences.

On-going Action Commission projects with the Czech Republic and Hungary are stressing science and engineering excellence particularly in the area of physics. These projects have reaffirmed the importance to high technology growth in Central and Eastern Europe of capitalizing on the international nature of science, and of fostering cooperation among business, government, institutes and universities. Physics and other sciences have emphasized discipline and order as well as the application of ethics, judgment, and responsible application that are at the core of successful entrepreneurship.

Transatlantic business and other private sector organizations have worked together on recent projects of the Action Commission that have stressed the following:

•Establishing a focus on technologies that reflect national priorities and the associated commitment of resources.

•Participation in organizations like the Association of University Technology Managers (AUTM), which advances in such sound technology transfer practices as the protection of intellectual property rights.

•Identification of high technology priorities and the establishment of workbench-level exchanges to define practical areas for actual cooperation.

•Expanded university-to-university exchanges that include the development of joint research projects of probable interest to business and investors.

•Encouragement of an entrepreneurial mindset that more efficiently manages the development and application of cutting-edge technologies.

Project activity is particularly linked to major associations such as the Association of University Technology Transfer Managers (AUTM). Joint ventures with the US for early stage research are increasing; for example, US Air Force research funding is permitting an exchange of possible applications of femtosecond lasers with a team from Budapest University of Technology and Economics. More advanced projects with US organizations are also prevalent. A joint US-Hungary venture, under the company Genetic Immunity, has an HIV/AIDS vaccine already in clinical trials.

At issue in building new joint ventures with the US is how to go about organizing a high technology venture that is likely to succeed. The following steps offer a framework for action:

•Awareness that US scientific activity is flexible and horizontal rather than hierarchical.

•Capitalizing on the fact that most US organizations identify their research priorities and view sciences as an international activity.

•Making contact at workbench level that is focused on established priorities and is the first step in a new high technology venture.

•Given practical grounds for cooperation, senior level agreement to commit resources to that joint venture is the next step.

New opportunities for high technology development with the leading countries of Central and Eastern Europe face lower risks and leverage a strong tradition of scientific excellence. This is an opportunity for the US government, businesses, universities and laboratories. In this period of transatlantic tensions, it may be that science and engineering cooperation in high technology ventures will become a valuable mechanism for restoring mutual trust and confidence more broadly across the Euro-Atlantic nations.

George W. Handy is Director of the Action Commissions Program at the Center for Strategic and International Studies in Washington.

**Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.*

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You will find the following in the online edition of *Reviews of Modern Physics* at http://rmp.aps.org

Doping a Mott insulator: Physics of high-temperature superconductivity

Patrick A. Lee, Naoto Nagaosa and Xiao-Gang Wen

One of the paths on the odyssey to a theory of high-temperature superconductivity is the "resonating valence bond" idea proposed by Anderson. This review discusses relevant experimental phenomenology and follows the mathematical developments of the idea, progressing from the mean-field theory of the t-J model and leading to strong-coupling gauge theories.

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MEMBERS IN THE MEDIA CONTINUED FROM PAGE 2

seeing the problem."

–Saul Perlmutter, UC Berkeley, on dark energy, SEED Magazine, November 30, 2005

"If one thinks of a nanomaterial as a house, our approach enables a scientist to act as architect, contractor and day laborer all wrapped up in one. We design the components of the house ... so that they will interact with each other in such a way that, when you throw them together randomly, they self-assemble into the desired house."

–Salvatore Torquato, Princeton University, on a new approach to manipulating nanomaterials, United Press International, November 30, 2005

"The main educational benefit is in their effect on the students' attitude toward the course. It creates a more relaxed classroom ... and makes the professor more approachable."

–Walter Smith, Haverford College, on singing songs about physics in class, Wired News, December 2, 2005

"Cyclotrons are not nuclear reactors. Probably the worst thing that could happen with small cyclotrons is that the operators might electrocute themselves."

– Roger Dixon, Fermilab, on an Alaska man who plans to assemble a cyclotron in his Anchorage house, Wired News, December 1, 2005

In insects, "the morphology (shape) of the wing has almost no role. What matters is not the shape of the wing but how the insect moves it. That's very different from conventional (airplane) aerodynamics, where the shape of the wing is everything."

–Michael Dickinson, Caltech, on how bees fly, San Francisco Chronicle, November 28, 2005

"Of course, you know how scientists are. We study things because they're there and there's a lot of interest in Mars these days because of the potential for flying humans there and the fact that Mars has a lot of similarities to Earth."

–Donald Gurnett, University of Iowa, on studying Mars, Iowa City Press-Citizen, December 1, 2005

APS APRIL MEETING CONTINUED FROM ON PAGE 1

Numerous special events are also planned for the April meeting, including a High School Teacher's Day on Friday, April 21. Educators in the Dallas vicinity will participate in hands-on workshops to learn about new and innovative activities for the classroom, and hear talks by researchers on select topics in cutting-edge physics.

Also on Friday, the APS Committee on the Status of Women in Physics is sponsoring an all-day professional skills development workshop for women physicists, targeted toward tenure-track and newly tenured women physicists. For more information, see www.aps.org/educ/cswp/skills/index.cfm.

TOO MUCH SCREAMING CONTINUED FROM PAGE 4

creationism, and then devotes most of his article to bashing creationism, Berman is not contributing to a helpful debate. In doing so, he strongly resembles physicist Lawrence Krauss, who has written frequently for the *NY Times*, repeatedly slurring intelligent design through "guilt by association" with creationism. As long as the scientific establishment engages in such tactics, a finite fraction of the American people will be completely turned off to science. It isn't necessary.

Creationism is gradually fading away on its own, and doesn't need to be bludgeoned by the science community. The unhappy fact that the creationists would like to hijack Intelligent Design Theory for their own purposes clutters up the issue, but does not automatically disqualify any scientist who questions Darwin. If a clear distinction between science and philosophy is upheld, as Miller counsels, science has nothing to fear–Intelligent Design is emphatically not a threat to all of science and society.

The reason that evolution is taught in biology classes is that it's the best theory we've got–just as in physics, Classical Mechanics was "the best theory we've got" in the 1920s. There is plenty of time, in college or grad school, to look into the ragged edges of Darwin's theory. Corrections and improvements to Darwinian evolution will appear through diligent scientific inquiry. Suppressing such inquiry out of a misplaced fear of "religious nuts" only slows down the progress of science.

Meanwhile, one perverse benefit of the entire controversy is that high school students will pay better attention because they'll want to know what the fight is all about, and hence they'll learn more biology along the way. Perhaps we could use something like that in physics.

Thomas P. Sheahen
Deer Park , MD

ZERO GRAVITY CONTINUED FROM PAGE 6

life evolved, and eventually the Bell telephone system broke up. Only a few great occurrences happened in the later stages of the universe. One very important event was the release of the album *Voulez Vous* by the Swedish disco band ABBA. Containing such disco classics as "Take a Chance on Me," it revolutionized the way the rest of the world looked at Scandinavian music and lent musical legitimacy to the disco sound.

How the Universe Will End. Some theorists believe that the universe will expand into a state of maximum entropy. Others think that the universe will collapse upon itself and start over in a process termed "The Great Cosmic Nervous Breakdown," perhaps joining a more stable profession afterwards, such as accounting. As to what will herald this end, philosophers, scientists, and theologians have disagreed for ages. Some believe the gods will walk the Earth, others that the stars will all vanish, and still others believe the Earth will stop turning. However, a majority now believe that the end will be heralded by the Milwaukee Brewers winning the World Series. The end of the universe is truly a long way away...

Based in Madison, Wisconsin, Eric Oehler is a software developer, font designer, and frontman for an electronic band called Null Device. He wrote this satire while a student at the University of Wisconsin, Madison. The full unedited article can be found online at www.12am.com/arshot.htm.

The Back Page

The Role and Promise of Physics Education Research

By Noah Finkelstein

An October 2005 report from the National Academies–entitled *Rising Above the Gathering Storm*–details the need for our society's investment in education, particularly in the sciences. Among other recommendations, the authors call for 10,000 new science and math teachers each year to educate ten million minds. In short, education is a fundamental form of society's investment in its future.

In many respects, however, we appear to be failing. The report from the National Academies documents the poor performance of our K12 students as well as significant challenges facing our college and even graduate students. The situation is yet worse for the poor and students of color. Furthermore, we have found that not only are our students not learning what we intend to teach them (both in K12 and college), but students are actually learning things we don't intend. For instance, in introductory physics, students tend to exit their courses with more novice-like beliefs about science and the nature of learning science than when they enter. We must address these vast challenges in a variety of ways–politically, economically, and through academic work.

Just as education is a fundamental form of investment in a society's future, research in education is a fundamental form of investment in the future of education. How we educate should be determined by thorough research in and understanding of our goals in education. To that end, over the past several decades physicists have built a community of researchers, a scholarship, and canon of work that focuses on education, learning, and teaching in physics. This field is known broadly as physics education research (PER). PER challenges how, when, why, and whom we educate.

Physicists have moved beyond the wishful thinking of common educational practice to a more studied and scientific approach to teaching. For example, perhaps our commitment to laboratory experiences for all students is borne out by the research, or perhaps not. Could it be possible that students who work with virtual equipment develop the same mechanical facility in the laboratory as students who work with real equipment? To address such questions, the PER community has conducted research that varies from challenging specific beliefs about student understanding to global structures of institutional change and what has and should be included in the education of our students. We have done so through a scholarship of research, debate, community consensus, verification and validation– just as any other sub-discipline of physics. It is the growth and success of PER that led to the significant APS Statement (99:2), endorsing research in PER as a staple and appropriate activity for the physics community.

At the same time, we might ask, why physicists? I do not suggest that it will be physicists alone who address the grave challenges of science education outlined above. However, physicists will be fundamental contributors to address these issues. The challenges of science education require the participation of physicists. It is we who have the content knowledge. For example, a thriving subgroup in the PER community studies how students learn and how to teach quantum mechanics effectively. It is a rare member of any other discipline–education, psychology or elsewhere–who has the necessary understanding of physics to deeply engage in many such questions.

Another clear reason to house PER within the physics community is that we are the practitioners who make use of the results of PER. Our charge as a community includes educating both current students and future teachers (as well as defining what it means to know physics). Meanwhile the complement is true. PER has benefited and grown enormously because it applies the tools of science to educational problems. We hypothesize, experiment, analyze, theorize, debate and reconcile our findings. Physicists' attention to education is not simply a matter of convenience and success, however. Focusing on social practices, and education in particular, is the morally conscionable act of physicists. Whether we like it or not, we are engaged in political acts, supporting or challenging existing paradigms and power structures. Finally, it is worth noting that physicists are very successfully conducting such research within physics departments. Currently there are over 100 PER faculty, in more than 80 physics departments, roughly 20 of which offer PhD programs with PER tracks. There is significant funding from NSF, a conference series published by AIP, and several publication venues, including a new Physical Review journal dedicated to PER.

Most broadly, PER has helped physics education move from an ad hoc, individualized and disconnected practice to a more scientific, collective, archived and incrementally developed practice. For instance, one of the frequent calls in education is to develop and promote on-line instruction. Huge investments have already been made and even greater investments are projected for the future. But how best might we leverage technology in our educational system? All too often we employ technology for its own ends. Careful research in PER can help guide the development and application of new technological tools for teaching and learning of physics. If we could have online laboratories for students, should we? In what manner? Current research addressing these questions is discussed below. For the moment, I briefly highlight a few of the achievements of the PER community. Many more thorough reviews exist and I recommend Redish's book *Teaching Physics* and recent articles in the *American Journal of Physics* or *Physics Today*.

Much of the early success of the field came from the study of student understanding and carefully engineered curricula designed to improve that understanding. Some seminal work in the field was the development and broad application of assessment tools to more reliably answer the questions of if and what our students learn. The Force Concept Inventory and other similar measurement tools (such as the FMCE, CSEM, BEMA and now tools in just about every field of physics) have been instrumental in persuading faculty that students are not learning what they believed (perhaps because of wishful thinking). Meanwhile, research-based curricula, such as the University of Washington *Tutorials in Introductory Physics* or *Physics by Inquiry*, which are designed with specific learning goals and are studied, refined and tested, have been shown to improve students' understanding of foundational concepts in physics, and even been shown to enhance students' traditional problem solving skills.

New approaches to classroom interaction have borne out theories of student learning that suggest that learning is an active process and particularly facilitated by encouraging students to be engaged in our educational environments. Mazur's *Peer Instruction* leverages technology to change the large-scale passive lecture environment into one where students are the ones "teaching themselves." (Of course the logical extension is that students don't need us–perhaps our ultimate goal.) Other educational practices, such as studio or workshop physics (variously developed and studied by Laws, Beichner, Belcher, Cummings and many other scholars) stem from the work of John Dewey who argued for such practices in the early 1900's. However, our approach to studying these scientifically, and iterating on what works based on data, is new.

More recently, researchers have been expanding the canon of questions, examining what and how we teach more broadly. In newly structured courses that promote students' understanding of content, researchers have documented that students do *not* necessarily develop scientific beliefs about the discipline. Researchers at Maryland (including Redish, Saul, Elby and Hammer) and more recently at Colorado (Adams, Perkins and Wieman) have documented that as a result of instruction in typical courses, students tend to believe that physics is more a matter of memorizing disconnected formulae that have little to do with the real world and less a coherent study of the world in a rational manner. These researchers have started to identify curricula and practices that effectively reverse these trends, and may well change students' interest and inclusion in the discipline.

In coupled work, researchers in the PER group at Colorado have started examining when and why technology may be helpful to address many of our educational challenges. In a study of learning by using computer simulations, students in a large-scale, introductory physics course were assigned to one of two educational conditions, one using real equipment and one using a computer simulation entitled the Circuit Construction Kit (CCK) available at phet.colorado.edu. Students completed identical labs using these different tools. As assessed by common, validated questions about electric circuits placed on the final exam, the CCK students demonstrated greater mastery of DC circuits, and performed indistinguishably on concepts not related to circuits. Somewhat surprisingly, on a coupled challenge to assemble a real circuit, the students who had worked only with virtual equipment demonstrated greater capabilities in manipulating the real equipment than their counterparts who had only worked with real equipment. This is not to say it is always preferable to work virtually. The most careful consideration ought be given to how and when we apply technological solutions to social problems.

Noah Finkelstein

PER also extends beyond classroom studies and studies of student thinking. A variety of lines of research seek to change the broader structure of education in physics and the sciences. One example, a joint effort of the APS, AAPT, AIP, the *Physics Teacher Education Coalition*, seeks to increase the number, preparation, and retention of the highest caliber physics teachers. Given that approximately two out of every three US high school physics teachers do not hold any physics degree, can we be surprised by our pre-college students' poor performance?

Other nascent research efforts in the community explore the continued low representation of women and people of color in physics and the physics classroom. Such efforts are designed not simply to figure out how to teach, but to examine how we might teach in a socially just and equitable manner. Other critical research examines institutional structures that support (or inhibit) the sustained and scaled implementation of reforms that have proven productive. These studies of disseminating and sustaining model programs occur because physicists seek to ensure that their efforts do not fall prey to the same fates as prior educational initiatives. For more, I encourage the reader to consult the rich and growing literature in the field in the *American Journal of Physics, Proceedings of the Physics Education Research Conference*, and the newly formed *Physical Review* online journal in Physics Education Research.

What challenges does physics education face? What distinguishes the hollow calls for education from more authentic calls? Action. Physicists, by building and supporting the field of PER, are acting–other disciplines are following suit. As with the growth of any new field, though, PER faces a variety of pressures and opportunities. Its dramatic growth and acceptance has proven productive; however, if we are to continue to see such dramatic success, we must actively support and choose to develop the field. Let us encourage others to act on the calls of the APS to support PER and its continued growth within physics departments.

At the same time we might act more broadly. Funding, as with all areas of physics and science research, is politically bound. We ought to follow former APS President Helen Quinn's call for our community to lobby and act collectively, and seek the support of education research within the sciences. I'm pleased to have worked with many members of the PER community, and with U.S. Senator Ken Salazar and his staff, to argue for eliminating the devastating cuts to NSF funding devoted to education research. (Recently these cuts were reported to be one third their initially proposal levels of roughly 50%.)

Finally, both practitioners and researchers of physics education will do well to be explicit about their goals as to why and how we teach physics. A broad span of motives fit within the umbrella of investing in our society and world's future. By being explicit about our goals and identifying how our actions are aligned with these goals (in the classroom, the boardroom, and faculty meetings), we may make great strides to an equitable, prospering and humane society.

Noah Finkelstein is an assistant professor of physics specializing in physics education research at the University of Colorado at Boulder, and he also is the leader of their PhysTEC project. While the views expressed herein are his own, he suspects others may agree with him.

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.