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APS physics

Attend the DPP Job Fair

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Apker Finalists Meet in Washington

Photo by Shelly Johnston

The APS Apker Award is given annually for outstanding research by an undergraduate. Finalists are chosen in two categories: from institutions that award PhD degrees, and from institutions not awarding the PhD. The finalists meet with the selection committee for a day of interviews, which this year took place on September 13 in downtown Washington. The committee then recommends recipients in each of the two categories to the APS Executive Board. Shown in the picture are the seven finalists. Front row, left to right: Nguyen T. T. Nguyen (Hamilton College); Shelby Kimmel (Williams College). Back row, left to right: Byron Drury (Haverford College); Gim Seng Ng (Wesleyan University); Sujit Datta (University of Pennsylvania); Michael Grinolds (Caltech); Gregory Minton (Harvey Mudd College). The recipients of the Apker Award will be featured in the December *APS News*.

Public Affairs Report Examines Nuclear Weapons Policy

The APS Panel on Public Affairs (POPA) will soon issue a joint report intended to provide guidance to the next administration on nuclear weapons policy. The report, *Nuclear Weapons in 21st Century U.S. National Security*, will be available on the APS web site after its release.

The APS, the American Association for the Advancement of Science (AAAS) and the Center for Strategic and International Studies (CSIS) collaborated on the report, which was drawn from a series of three workshops held earlier this year covering three separate tracks: technical, military and international. The workshops brought together experts from the scientific, defense and diplomatic policy communities. A fourth "integration" workshop brought together results from the three tracks.

The most urgent issues identified by the report are: preventing the spread of nuclear weapons, especially to North Korea and Iran; securing and reducing global inventories of nuclear weapons to prevent them from falling into the hands of terrorists; and engaging Russia in a new strategic dialogue.

It states that a clear statement of policy on nuclear weapons will be needed from the next president.

"Renewed interest in US nuclear policy has been stimulated in the past year through a series of editorials by distinguished statesmen and by the appointment of a congressional commission to look into these matters," said John Browne, chair of the APS Panel on Public Affairs (POPA) subcommittee on national security.

"This report identifies a possible way to bring together disparate views regarding the appropriate role of U.S. nuclear weapons in our 21st-century defense strategy," said Browne. "We identify the opportunity to pursue a parallel approach that regains leadership in global nuclear nonproliferation through a series of initiatives while continuing to refurbish and update our nuclear stockpile and infrastructure as necessary without creating any new nuclear weapon capabilities."

There has not been a coherent statement on the role of nuclear weapons for security in a post-9/11, post-Cold War world, the report states.

"Such a 'centrist' approach as outlined by this paper has been lacking, causing our nuclear policy to drift for a decade or more," said Browne.

In order to re-establish the US role as a leader in nonproliferation, the report suggests several possible steps, including ratification of the Comprehensive Test Ban Treaty. The US should also address the challenge of expanding use of nuclear energy without increasing proliferation risks. Some possible steps

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LaserFest to Celebrate 50 Years of Laser Innovation

The APS has joined with the Optical Society of America (OSA) in planning LaserFest, a multi-year series of events and activities centered on 2010 commemorating the fiftieth anniversary of the invention of the laser in 1960.

"Every time we give a presentation using a laser pointer, see a laser light show, watch a DVD or benefit from bloodless surgery or laser eye correction, we are profiting from the work of our colleagues who were the founders of this technology," said APS President Arthur Bienenstock and OSA President Rod Alferness in a joint statement.

When it was first invented, the laser was called a "solution looking for a problem." Today the laser is used in thousands commercial applications ranging from barcode scanners to laser surgery, and as a scientific research tool.

The laser resulted not from a single breakthrough by one individual, but from a series of developments. Albert Einstein in 1917 presented the concept of stimulated emission,

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2008 Nobel Prize Goes to Nambu, Kobayashi and Maskawa for Work on Broken Symmetries

The 2008 Nobel Prize for Physics has been awarded to three physicists whose insights help to explain fundamental properties of both the strong and the weak interactions. Half the prize goes to Yoichiro Nambu (University of Chicago) "for the discovery of the mechanism of spontaneous broken symmetry in subatomic physics." Half will be shared by Makoto Kobayashi (High Energy Accelerator Research Organization Tsukuba, Japan) and Toshihide Maskawa (Yukawa Institute for Theoretical Physics, Kyoto University) "for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature."

Among Nambu's key contributions was the realization, in the early 1960's, that the strong interactions exhibit spontaneously broken chiral symmetry, which can be used to understand both the existence of the light pion and the origin of the nucleon mass. Kobayashi and Maskawa's most important contribution came more than a decade later, as the standard model was being constructed. They generalized the 2x2 quark mixing matrix that had been introduced by Cabibbo to the 3x3 case, thereby introducing an extra generation of quarks and showing how CP violation could enter naturally into the standard model.

"This year's prize recognizes two theoretical pillars of our modern understanding of the fundamental constituents of matter and the forces that act on them," explains APS Vice President Curtis Callan of Princeton University. "Nambu profoundly deepened our understanding of mass. His prescient work of the early 60s today allows us to explain how the proton and neutron (and, by extension, the atomic nucleus) can be made of nearly massless quark constituents and yet

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APS Awards First Industrial Physics Prize to Philip J. Wyatt

The APS has awarded its first Prize for Industrial Applications of physics to Philip J. Wyatt, founder and CEO of Wyatt Technology Corporation in Santa Barbara, California. Wyatt was honored "for pioneering developments in the physics of the inverse scattering problem: new application of laser light scattering and the successful sustained commercialization of new related analytical methods and instrumentation."

Established in 2007, the APS prize complements the American Institute of Physics' biennial Prize for Industrial Applications of Physics, first established in 1977. The APS prize is awarded in alternate years to an individual, or individuals, for applications of physics in an industrial setting. The purpose of the prize is to recognize excellence in the industrial application of physics, and thereby to publicize the value of physics in industry, to encourage physics research in industry, and to enhance students' awareness of and interest in the role of physics in commercial product development. Both prizes are supported by a grant from the General Motors Corporation.

Wyatt earned his PhD from Florida State University; his thesis research focused on the development of a non-local nuclear model capable of describing scattering of neutrons by nuclei. It was his first exposure to the classical inverse scattering problem, in which one studies the manner by which radiation scatters from an object to deduce the nature of the interaction, and, by extension, the physical properties of the object itself.

Early on in his professional career, Wyatt developed several instruments to explore the inverse scattering problem, and decided to found his own company to market laser-based light scattering and related instrumentation. Today, Wyatt Technology Corporation is 27 years old, and its instruments are sold in over 50 countries and are used in virtually all universities, major biotech and pharmaceutical firms.

But the road to entrepreneurial success in industrial physics was far from smooth. The first company Wyatt founded failed. He attributes the failure to bad timing: at the time, "nobody believed our laser light scattering techniques were going to literally revolutionize analytical chemistry." By the time Wyatt founded WTC, laser technology had become much more commonplace, and market trends had shifted in his favor– his product had become a "pull" technology.

He also benefited from a lucky break. A light-hearted experiment using his instruments to monitor the quality of cola drinks became a cover story in *Applied Optics*. Coca-Cola took notice, and decided to invest in Wyatt's work–in part, he admits, to protect their secret formula. The company has since grown dramatically. His hard-won advice to aspiring entrepreneurs: "Get into a market that is just on the verge of developing. If you're too early, the company fails. If you're a little too late, the competitors will eat you alive because they have much better resources."

Among other applications, Wyatt's instruments are used to monitor the evolution of individual smog particles and the effects of fly ash, as well as detecting drug and pesticide residues in meats. He also

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Members in the Media

"Wouldn't it be cool if we saw a particle go into another dimension? And then come back out?"
***Wesley Smith**, University of Wisconsin, Madison,* Wisconsin State Journal, *September 10, 2008*

"I'm not worried. There is no credible calculation to show these microscopic black holes could grow."
***Benjamin Harms**, University of Alabama, on the microscopic black holes the LHC could produce,* Tuscaloosa News, *September 11, 2008*

"If 96 percent of the stuff in the universe is foreign to us, it's pretty interesting for us to ask what that is."
***Gary Hinshaw**, NASA, on dark energy,* The Washington Post, *September 26, 2008*

"Switzerland was neutral, and believe it or not, it was cheap. It is still neutral."
***Lyn Evans**, CERN, on why CERN was build in Switzerland,* The Washington Pos*t, September 11, 2008*

"Science is not something you have to go to a laboratory to do. Life is a lab."
***Walter E. Massey**,* Chicago Sun-Times, *September 17, 2008*

"This is the first time, as far as I know, that both major candidates for president have responded to a set of questions about science for the public. Both responses are more comprehensive than I had expected."
***Lawrence Krauss**, Arizona State University, on Science Debate 2008,* The Cleveland Plain Dealer, *September 19, 2008*

"This is arguably the largest machine built by humankind, is incredibly complex, and involves components of varying ages and origins, so I'm not at all surprised to hear of some glitches. It's a real challenge requiring incredible talent, brain power and coordination to get it running."
***Steve Giddings**, University of California, Santa Barbara, on delays at the LHC,* The Boston Globe, *September 19, 2008*

"I'm a wanderer. I tend to be maybe too curious about too many things. And most of the time I fail in satisfying that curiosity. But one curiosity leads to another."
***L. Mahadevan**, Harvard University, on his scientific interests,* The Boston Globe, *October 6, 2008*

"I think one of the differences between the special election and this election is that most people have a much better idea of who I am."
***Bill Foster**, running for re-election to Congress,* Associated Press, *October 4, 2008*

"Theorists say the Higgs is a certainty. I'm an experimentalist; I need to see it."
***Stan Durkin**, The Ohio State University,* Columbus Dispatch, *September 23, 2008*

"Our entire world as we know it normally relies on the existence of an up quark and a down quark, an electron and a neutrino. You don't need anything else to make up our universe. We don't have any idea why the second and third sets exist."
***Hugh "Brig" Williams**, University of Pennsylvania,* Philadelphia Inquirer, *September 22, 2008*

"Real breakthroughs are not found because you want to develop some new technology, but because you are curious and want to find out how the world is."
***Anton Zeilinger**, University of Vienna, on quantum cryptography,* BBC News Online*, October 9, 2008*

WYATT continued from page 1

developed instruments and methods to select the most effective antibiotics for combating bacterial infections in chemotherapy patients, and others to monitor AZT (a highly toxic drug) levels in AIDS patients, as well as monitoring the toxicity of antineoplastic drugs.

Combating bioterrorism is another application area. For instance, drinking water supplies could be vulnerable, so Wyatt developed instrumentation capable of determining within an hour whether any carcinogens or metabolic poisons are present in a given sample. Other instruments were developed to monitor and analyze airborne bacteria.

This Month in Physics History

November 1919: Elmer Imes Publishes Work on Infrared Spectroscopy

Elmer Samuel Imes, the second black PhD physicist in the United States, and the first to do significant research work, published his first paper in November 1919. The work provided the first accurate determination of the distances between atoms in molecules, expanded the range of applicability of quantum theory, and provided evidence for the existence of two isotopes of chlorine. His research was cited many times and was soon incorporated into textbooks.

Elmer Imes was born in October 1883 in Memphis, Tennessee, the son of missionaries. He attended elementary school in Ohio and high school in Normal, Alabama. He received a bachelor's degree in science in 1903 from Fisk University, a predominately black university in Nashville, Tennessee.

Photo courtesy of AIP

Elmer Samuel Imes

After receiving his degree, Imes taught physics and math at the Albany Normal Institute in Albany, Georgia. Around 1910, he returned to Fisk, where he continued his own studies in physics and served as an instructor of math and science. He completed his master's degree in 1915. Fisk didn't offer any higher degree, so he transferred to the University of Michigan to complete his PhD.

At the University of Michigan, Imes worked in the laboratory of his advisor Harrison Randall, designing and building high-resolution infrared spectrometers and detectors.

Imes earned his PhD in physics in 1918, becoming the second African American to earn a PhD in physics, more than 40 years after Edward Bouchet received his PhD from Yale.

Imes' thesis work involved infrared spectroscopy of diatomic gases HCl, HBr and HF. His main findings were reported in a paper, "Measurements on the near-infrared absorption of some diatomic gases," published in November 1919 in the *Astrophysical Journal*. Imes and Randall followed up with some further details in a paper presented at an American Physical Society meeting in November, and a paper in *Physical Review*.

His work, one of the first applications of high resolution infrared spectroscopy, provided the first detailed spectra of simple molecules, and opened up the field of studying molecular structure through infrared spectroscopy. Imes analyzed hydrogen bromide (HBr), hydrogen chloride (HCl), and hydrogen fluoride (HF). The work presented the first accurate measurement of the distance between atoms in molecules.

The research also provided a verification of quantum theory. Before Imes' study, some scientists were not certain whether quantum theory applied to the emission spectra of molecules. Imes' work showed that quantum theory could be applied to the rotational energy states of molecules as well as the vibrational and electronic energy levels.

In 1919, about a year after completing his PhD, Imes married Nella Larson, a well-known poet of the Harlem renaissance. The couple lived in New York and became part of the Harlem intellectual society. He came into contact with prominent African American intellectuals including W.E.B Du Bois and Langston Hughes.

Imes' research was recognized as important by colleagues, and was frequently cited, but the only faculty positions open to Imes were at black colleges and universities, which didn't have graduate programs.

So after receiving his PhD, Imes left academia to work in industry in the New York region. He worked as a research physicist at Federal Engineers Development Corporation for a few years, then at Burrows Magnetic Equipment Corporation, and then as an engineer at the E. A. Everett Signal Supplies.

During that time his work resulted in four patents for instruments for measuring magnetic and electric properties of materials.

Imes found few opportunities to advance in industry, and in 1930, after a decade in industry, he returned to Fisk University.

At Fisk, Imes served as the chair of the physics department. He revised the undergraduate programs and planned a graduate program in physics.

Although he didn't publish any more of his own papers, Imes did remain active in the research community. He corresponded frequently with other researchers and equipment designers and continued some of his own work in infrared spectroscopy.

Imes was dedicated to training students, and conducted research with his students at Fisk. Students in his research lab used x-rays and magnetic techniques to study properties of various materials. He sent some of his students to work at the University of Michigan in the summers to learn x-ray techniques. His research lab was described as "a mecca for those who sought an atmosphere of calm and contentment," by W.F.G Swann in an obituary.

Believing that students should be exposed to the history of science, Imes also developed a course called "cultural physics," and wrote a book-length treatise covering the history of science from the Greeks through the early twentieth century.

While on the faculty at Fisk, Imes became involved in a scandal involving a relationship with a white administrator, which, along with other troubles, led to his divorce from Nella Larson. He also experienced financial difficulties from which he never fully recovered. By the late 1930s, his health was declining. He returned to New York, where he died in September 1941.

Throughout his career, Imes was an active member of APS, as well as several other scientific societies.

Reference: Mickens, Ronald. *"*Elmer Samuel Imes–Scientist, Inventor, Teacher, Scholar.*"* In *Edward Bouchet—the First African American Doctorate*, World Scientific Publishing Company (2002).

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Bringing a Sun to Earth: Briefing Explains ITER Fusion Experiment

By Nadia Ramlagan

A September briefing on Capitol Hill was held to drum up support for ITER funding in the Fiscal Year (FY) 2009 budget, after negotiations between Congress and the White House on the FY 2008 budget left $160 million of ITER funding nearly "zeroed out".

As a result, ITER-related research received only $10.7 million in funding. However, funding could be restored next year, as both the House and Senate appropriations packages for FY 2009 include full funding for US contributions to ITER.

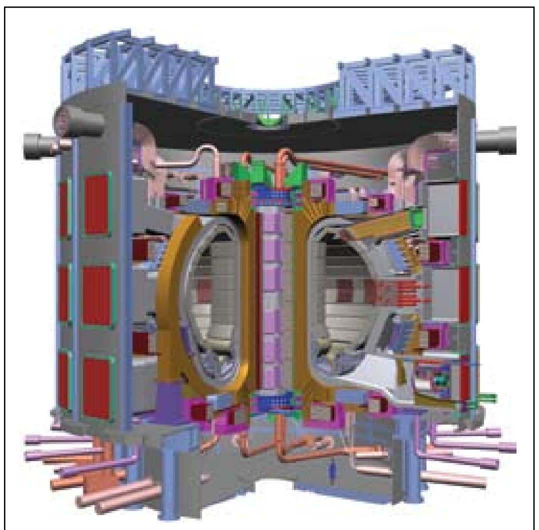
Ned Sauthoff, Director and Project Manager of the US ITER project at Oak Ridge National Laboratory (ORNL) discussed the science of fusion, the ITER experiment, and benefits of US participation. Representative Rush Holt (D-NJ) also spoke briefly, stressing the importance of participating in large-scale international research projects, and the enormous potential of fusion power to solve serious energy resource and environmental problems currently facing the US and the rest of the world.

ITER is an international project that aims to demonstrate the scientific and technological feasibility of fusion energy. In 2006, the United States, countries of the European Union, Japan, Russia, South Korea, and India signed an official agreement to build the experiment at Cadarache, in southern France. Built with hardware manufactured from all 6 parties, ITER will use strong magnetic fields to confine burning torus-shaped plasma at temperatures around 200 million degrees K, producing nearly 500 million watts of power. Early construction of the ITER facility is underway, and the device is set to begin operation in 2016.

As the host country, France is expected to pay about 50 percent of total costs. Each of the other 5 parties pays roughly 9-10 percent, "but gets access to all data, the right to propose and conduct experiments, and is a joint owner of the intellectual property rights," said Sauthoff.

ITER will fuse deuterium and tritium together to form helium and a neutron, while releasing 10 times the amount of energy originally needed to make the nuclei fuse. If all scientific objectives are met and ITER is successful, it will be the first fusion reactor to create significantly more energy than it uses.

Sauthoff showed images of Dr. Otto Octavius, the main villain in 2004's Spider-Man 2. The comic's notorious mad-scientist wants to overrun the world with cheap fusion power. "Hollywood says fusion is a part of our future," he joked. Aside from its movie appeal, fusion is attractive for several reasons. It is safe, involves no emission of greenhouse gases, and is capable of large-scale energy production.



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The ITER device

To illustrate fusion power's cleanness and efficiency, Sauthoff compared a 1,000 MW coal-fired plant to a 1,000 MW fusion plant (both provide enough energy to power 500,000 homes). Each day, a coal fired plant consumes 9,000 tons of coal and produces 30,000 tons of carbon dioxide, 600 tons of sulfur dioxide, and 80 tons of nitrogen dioxide. In stark contrast, a fusion plant would consume 1 pound of deuterium, 3 pounds of lithium-6 (1.5 pounds of tritium), and produce a mere 2 pounds of helium-4 (0.5 pounds of neutrons).

Self-sustaining fusion reactions or "burning plasma" can only occur at extremely high temperatures. Because the plasma is too hot to be contained by any material, strong magnetic fields are used to hold it in place, providing a shield from the walls of the reactor. The magnetic confinement of fusion is also inherently safe. "If the plasma hits the wall, it cools itself and the reactor shuts itself down," explained Sauthoff.

Aside from personnel and funding for basic expenses, in-kind US contributions to ITER include hardware and instrumentation. The US will produce ITER's 8,700 ton magnet system, using niobium stannide (Nb3Sn) coils to produce toroidal fields which will confine and stabilize the plasma. Positioning and shaping of the plasma will occur by niobium titanium coils, and a modular Nb$_3$Sn central solenoid coil will be used to induce current in the plasma. "The US is supposed to supply 40 tons of niobium tin superconducting wire, so the superconducting industry is very excited about this," Sauthoff said.

The US will supply 20% of the tiles that absorb the power from the plasma, comprising blanket, port limiter, and diverter systems. In addition, 100% of the ion and electron cyclotron systems' transmission lines will be supplied by the US. "We [the US] are also fueling the plasma," Sauthoff said. ITER's burning plasmas will be fueled primarily by injection of frozen hydrogen, deuterium, and tritium pellets into the tokamak. "We call that a snowball in hell," Sauthoff noted. Once pellets enter the plasma they ablate, adding fuel particles to the plasma core that subsequently results in high fusion gain.

"At home" research and development will ensure that the US is a future supplier rather than a buyer of fusion technology. The US ITER team (predominantly based at ORNL) is engaging industry and educational facilities across the nation in research and development, engineering, design, and fabrication. There are currently 160 companies and universities in 33 states and the District of Columbia working on ITER.

"Not only is ITER a scientific and technological experiment, it is equally an experiment in international collaboration. We have to learn how to work together and develop project management with other cultures," said Sauthoff.

The briefing was sponsored by the American Society of Mechanical Engineers (ASME) and the Institute of Electrical and Electronics Engineers (IEEE), and held in conjunction with the Congressional Research and Development Caucus.

Chicago Area Fellows Convene

Photo by Darlene Logan

On October 2, APS hosted a reception for Chicago-area Fellows at the Quadrangle Club in Hyde Park. About 80 Fellows and guests were on hand to enjoy the refreshments and hear remarks from APS President Arthur Bienenstock, APS Director of Education and Diversity Ted Hodapp, and APS Director of Public Affairs Michael Lubell. In the photo, at left, are two retired Fellows from Argonne National Laboratory, Natalia Meshkov and Caroline Herzenberg. They are joined by Fellow Guy Savard of Argonne, at right. Enjoying his position in the middle is Leonard Herzenberg.

Meeting Briefs

•The APS Ohio Section held its annual fall meeting October 10-11 in Dayton, Ohio, co-hosted by the Air Force Institute of Technology and Wright State University. Topics included ultrafast dynamics with laser-produced soft x-rays; proteins and other "foldameric" materials; the connection between solid state physics, nanotechnology, and the environment; and spectroscopic indicators of life on other planets. Marc Abrahams, editor of the *Annals of Improbable Research* and founder of the annual Ig Nobel Prize ceremony, gave a public lecture.

•The APS New England Section held its annual fall meeting October 10-11 at the University of Massachusetts in Boston, organized around the theme, "Out of Equilibrium." The invited speakers addressed such topics as entropy and "temperature" of granular packings; single molecule dynamics in cell division; controlling the motion of ultracold atoms; nonequilibrium phase transitions in thin granular layers; the equilibrium and non-equilibrium behavior of liquid water in bulk, nanoconfined and biological environments; the eigenstate thermalization hypothesis and quantum thermodynamics; and the structure and dynamics of a uniformly heated granular fluid, among others.

•The APS Texas and Four Corners Sections held a joint annual fall meeting at the University of Texas in El Paso. Topics discussed by invited speakers included liquid crystals, astrophysics, semiconductors, K-12 education, science policy, and nanoscience. Friday evening's banquet featured a talk by Thomas Calligaro (Centre de Recherche et de Restauration des Musees de France, the Louvre) on the use of particle accelerators to aid new discoveries in art and archaeology.

•The APS California Section held its annual fall meeting October 17-18 at California State University at Dominguez Hills in Carson, California. Invited speakers addressed such topics as the search for gravitational waves with LIGO, how the Large Hadron Collider heralds the onset of a new revolution in physics, the science of the Large Synoptic Survey Telescope, and an update on the National Ignition Facility. The keynote speaker at Friday evening's banquet was Uwe Bergmann (SSRL), who spoke about what scientists can learn about an ancient manuscript by Archimedes using synchrotron radiation sources.

Board Passes New Policies on Unit Newsletters, Committee Funding Requests

At its meeting in late September, the APS Executive Board instituted two new policies, one regarding unit newsletters, and one regarding requests for funding from APS committees.

Last summer, material published in the newsletter of the Forum on Physics and Society was picked up first by blogs and then by the media, resulting in inaccurate and inflammatory reporting including the erroneous claim that APS had changed its position on anthropogenic global warming. Taking note of the way in which information, and misinformation, can propagate on the internet, the Board mandated a policy on unit newsletters requiring "a disclaimer on each paper and electronic newsletter file, including the statements that the article has not been peer reviewed and does not necessarily represent the views of the APS." In addition, the policy requires the establishment of a unit Editorial Board to oversee the publication of newsletters for units whose newsletters regularly carry editorial or opinion articles.

The Executive Board also approved the following policy regarding APS committee requests for activity funding for amounts over $10,000: "Occasionally APS Committees wish to start new programs that will need additional APS funding. This requires that these programs be considered for inclusion in the budget for the following year. Committees that wish to request over $10,000 additional funding for the following year should make a brief written proposal and submit it to the Executive Officer by April 1. The Executive Officer will make sure that all such proposals are put before the Executive Board at its spring meeting. The Executive Board will then make recommendations to the Budget Committee about the inclusion of the new programs in the APS budget. The final decision of the Council will, of course, be influenced by the projected income and other needs of the Society."

NOBEL PRIZE continued from page 1

be very massive. Kobayashi and Maskawa developed a description of the intrinsic mass of the three generations of quarks which has been verified in spectacular experimental detail. It provides a framework for understanding why matter vastly dominates over anti-matter in our universe and also how neutrinos can change their character as they propagate to the Earth from the Sun."

All three of the 2008 Laureates have previously been recognized by the APS with the J. J. Sakurai Prize for Theoretical Particle Physics (Kobayashi and Maskawa in 1985, and Nambu in 1994). Nambu also won the 1970 APS Dannie Heineman Prize for Mathematical Physics. Nambu's initial papers leading to his portion of the prize in appeared in APS journals nearly fifty years ago.

"We are pleased that Nambu's work was published in *Physical Review Letters* in 1960," says APS Editor-in-Chief Gene Sprouse, "in the then-nascent journal's second year of publication." This article is freely available online at http://link.aps.org/abstract/PRL/v4/p380.

In addition to his Nobel Prize winning work, Nambu was also one of the progenitors of string theory, having proposed the action for a relativistic bosonic string.

Letters

Saving Physics in America

Leo Kadanoff wrote an interesting article on physics aspirations and goals on the Back Page of the July 2008 issue of *APS News*. In this article, he raised the concern of a decline in US physics research. With the recent funding debacles of ILC and ITER and the financial crisis at Wall Street, there are some jitters among many physicists. Concurrently, America just witnessed China's first space walk. China has already passed the US in at least one area of scientific research—namely high temperature superconductor physics.

In the past, US partially relied on the import of scientific talents from other countries to sustain its science and technology. As the retention rate of foreign scientists drops, the US physics work forcewill weaken unless a local supply of fresh blood is infused into the system. As Kadanoff has so keenly observed, better physics education will be a strategic component of a multi-prong approach to arrest the decline of US physics.

Good teaching skill essentially consists of detailed preparation for lectures, speaking clearly to the students, paying attention to blackboard etiquette, answering students' questions respectfully, and most importantly writing reasonable quizzes and exam questions. Students generally learn best from other students. We can certainly encourage students to work in groups to solve physics problems so that they have a natural setting for mutual-teach. It is contrary to the old school methodology of requiring students to work independently.

Another idea is to encourage more faculty-student interactions. Intensive faculty-student interactions provide another form of social support to stimulate learning. Students learn better in this environment. Unfortunately very few research universities can afford the economy of intensive faculty-student interactions. However, undergraduate research can provide a setting for undergraduate students to collaborate with graduate students and postdocs.

Physics education is more than classroom teaching. It also involves apprenticeship training. For quite some time, many graduate students and postdocs have been burned under the old system. Graduate students and postdocs are utilized to provide labor to sustain the research enterprise. At the same time, they are put in the pipeline to become future competitors against their supervisors for prestige and research money. Shrewd supervisors will understand the strategic advantage of teaching graduate students and postdocs well enough to serve a purpose for a short time but not well enough to become future competition. As funding sources dwindle, these kinds of behavior will likely increase. If abuses widen, the number of graduate students and postdocs may further decline to drive the downward spiral of US physics even deeper.

Assuming that we have the best students undergoing the best training under the best professors, there is still a chance that these students will not succeed in finding permanent academic jobs in physics. NSF's Science and Engineering Indicators in 2008 shows that only 20% of the postdocs get permanent jobs (http://www.nsf.gov/statistics/seind08/). Given the fact that only a small fraction of PhD graduates get postdoc jobs, the overall success rate of all those who enter into vocational physics training is probably just 5%. Prospective students are often aware of the statistics. Unless the employment problem is resolved, we continue to limit the physics gene pool by losing students to engineering and computer science.

Given the bleakness of the physics job market, we need to prepare our students for the rainy days by educating them about various options in non-traditional physics jobs. A supervisor may not be able to provide training in non-traditional physics vocations per se; but he can at least give general advice to his students and send them to job fairs. The important idea is to create a safety net for the unlucky majority so that the flow of talents does not seize up.

Alfred Tang
Hong Kong

STEM is not Forever

I was pleased to see the Back Page analysis on the STEM Workforce in August/September attempting to look at the issues from several sides, but Professor Hira has avoided one key reality: STEM careers will not last a lifetime for Americans in the 21st century. Rather, STEM careers are like those in professional sports, something to aspire to while young. Some will make it big, like Bill Gates, but even Gates had to find something else to do in his middle years. Most will struggle in their 40's and 50's to feed their families and educate their children. Talented students recognize this and seek credentials in more stable fields, like marketing and law.

To keep on top of a technological world, our country will need to import talent, but in a way that encourages STEM workers to earn enough to retire in their lower-cost home countries by age 50. The H-1B visa–which is a form of indentured servitude–really doesn't do that, although it serves the interests of employers by keeping salaries down.

Professional associations like the APS can help by creating options for those exiting the STEM workforce in mid life. STEM workers could be re-trained for the manipulation economy; working as insurance adjustors, investment advisors, creative accountants, mortgage brokers, and in other professions requiring numeracy. What is missing are the educational programs and fellowships to help us make the transition. If a life-long career path were visible, American students might come back to our fields.

Marc D. Levenson
Saratoga, CA

Licence to Publish Better than Copyright Transfer

Regarding the recent correspondence on APS's approach to copyright: I work for a commercial organisation, in the R&D group, and my company's policy is very simple. We NEVER transfer copyright to a publisher. We have a Licence to Publish agreement, which allows the publisher to print the article in their own format (which we are not allowed to reproduce) and distribute electronically etc. Crucially, however, the copyright on the *content* is retained by my organisation. This allows us to use text, pictures, etc. from our article as we wish.

If a publisher does not accept the Licence to Publish agreement, then we simply do not publish in that publisher's journals.

I am sure mine is not the only commercial organisation that has such a copyright policy, and I would be amazed if the APS had never agreed to use such an agreement for publishing, when an author's employers have had a similar policy to my own company. There is no reason why academic organisations should not adopt such a position too.

R.I. Taylor
Chester, UK

LASER continued from page 1

which was later experimentally verified. The maser, a precursor to the laser, was developed in 1954 by Charles Townes and independently by Nicolay Basov and Alexandr Prokhorov. Townes and Arthur Schawlow published an important paper on the theory of the laser in *Physical Review* in 1958, which led to the first patent for a laser awarded in March 1960, and the first demonstration of a working laser two months later by Theodore Maiman at Hughes Research Lab.

To celebrate the laser, APS and OSA are planning a wide variety of events at the local and national level. LaserFest activities are intended to reach students and teachers, policy makers, and the public.

A website devoted to LaserFest (LaserFest.org) will include information about the laser, an up-to-date list of LaserFest events, and instructions on how to participate. A preliminary version of the site was launched in September.

Educational activities such as PhysicsQuest, an APS activity kit for middle school students, will have a laser theme for 2009-2010. APS plans to develop other educational materials as well, including posters for classrooms and a laser-themed activity book for young children. APS also plans to produce and distribute videos.

Throughout the year, public lectures, symposia, debates, laser shows and demonstrations will highlight the laser's history and applications.

OSA will encourage its student chapters to organize laser days to be held in communities, schools, and on college campuses. Chapters of the Society of Physics Students are also expected to get involved in organizing events.

APS and OSA will each contribute their own resources, and are seeking additional funding from NSF and DOE for LaserFest.

Many LaserFest events will take place during 2010, though OSA has already hosted some events. A symposium honoring Theodore Maiman, who died in 2007, was held in San Jose in May at the CLEO/QELS conference. In October, the *Schawlow-Townes Symposium on 50 Years of the Laser*, marking the fiftieth anniversary of the of the publication of the classic paper by Schawlow and Townes [Infrared and Optical Masers, *Phys. Rev.* 112, 1940 (1958)], was held in conjunction with the Frontiers in Optics (FiO)/APS-DLS Laser Science meeting in Rochester, NY. The symposium featured a presentation by Charles Townes on the early history of the laser.

zero gravity

The Lighter Side of Science

If Science Were an Olympic Sport

by Duncan Hull

A fictional scene from the future: The Olympic games, London 2012. A new candidate sport is on trial, joining skateboarding, rugby and golf at their debut Olympic games. It is challenging discipline called Science, a sport more ancient than Olympia itself. The crowd awaits eagerly in the all new Boris Johnson Olympic stadium. It has taken more than 2000 years just to convince the International Olympic Committee that Science is worthy of being an Olympic sport. The big day has finally arrived but the judges are still arguing about how to award the medals to scientists. Despite all the metrics involved, it's all very subjective. The games go ahead anyway, and there are lots of exciting new events:

Triple-jump grant-writing

A massive run-up, then a big hop, huge step, followed by a colossal jump. Longest triple-jump wins all the grant money from the funding body.

Experiment wrestling and judo

Contestants wrestle and fight with poorly understood but state-of-the-art technology in order to test hypotheses and perform experiments.

Only the most determined contestants get results, the winner is the person with the most interesting discoveries.

Impact factor boxing

A barbarically macho, gruesome and bloody event. Competing scientists try to publish in the journal with the highest impact factor but of dubious real value. This event often has many casualties and opponents are often beaten until they are unconcious, fall over, or even die. Publishers usually win this event, rather than scientists.

Closely related to citation gymnastics where the scientist with the largest h-index wins.

Invention javelin

Contestants try to invent the sharpest new things at the cutting edge of science and technology. Best invention is judged to be the longest throw of the invention javelin.

The 200 m peer-review hurdles

Contestants have to run as fast as they can clearing all the hurdles laid down by their peers and publishers. First to cross the finishing line wins the publication.

The lonely long-distance marathon research run

Scientists develop expertise by running a single course for several years or even decades. Trainee scientists are recruited by running a special marathon called a PhD or DPhil. Any competitors left standing after the allotted time are given the title "Doctor," for passing the gruelling initiation and endurance test.

Presentation fencing

Contestants publicly present their work to other scientists and colleagues often using a blunt instrument called "PowerPoint," and opponents seek weak points in presentation using sharp instruments. Touché!

Student shot put

Contestants throw cumbersome, heavy, and almost inanimate objects (called "students") as far as they can. The winner is the person who can throw a student the furthest.

Weightlifting with citations

Contestants write long review papers. The person who can cite the most papers in a single publication wins. Current world-record unknown but 2,184 references in a single paper is a pretty high score. If you've ever written a scientific paper, what is your "personal best?"

The multi-disciplinary decathlon professorship

A real test of a wide range of abilities, combining all of the above

OLYMPIC continued on page 5

Mass Media Fellows Describe Their Experiences

Editor's Note: *Each year APS sponsors two mass media fellows, typically graduate students or graduating seniors in physics or a closely related science, who spend eight weeks over the summer working as science journalists in a program administered by AAAS. This year's fellows were Carrie Nugent, who is a graduate student at UCLA, and Zoe Buck, who received her bachelor's degree from Princeton last spring. In these articles, the two fellows let APS News readers know how they fared in their journalistic debuts.*

Sharing the Love in Oregon

By Carrie Nugent

I ran to my editor.

"Susan! Lizards! I'd like to write an article on lizards."

"Ok, Carrie," she said."What's the news about lizards?"

I was at a loss. There wasn't anything newsworthy that week on lizards. In fact, there are barely any lizards in the great, generally wet state of Oregon, where I was working for a newspaper, *The Oregonian*.

As a scientist, I become enraptured with an idea for its own sake–but that doesn't make it news. And newspapers only contain news.

I know, it sounds obvious. But as my ten weeks progressed, I'd interview scientist after scientist who would make the same mistake. Seeing how a newspaper works from the inside will undoubtedly improve any future dealings I have with the media. It was also an awesome way to spend the summer.

During my summer at *The Oregonian*, I didn't find any news about lizards, but I did drive through hilly central Oregon, where my car's brakes failed. I saw volcanoes, Saturn's rings, and a 30,000-species aphid collection. I met a man who will identify any insect–dead or alive–that is mailed to him, a woman who travels the globe collecting bacteria samples, and a Canadian who nervously drove around New Hampshire with a collection of homemade birdsong players that look a whole lot like bombs.

I worked side-by-side with some of the most talented and intelligent people I have ever met.

I overcame my awkwardness on phones. But not before my words jammed and I asked a prominent ecologist about his work on elves in national parks–instead of his work on elk and wolves.

The most rewarding articles I wrote, however, were not the ones that involved adventures or curious personalities. Instead, it was the series of home science experiments that can be performed for under five dollars. Many of the experiments I learned from my college physics professors. They were fun, they were easy, and they taught good science.

They ran next to the advice columns.

People loved them. I got calls from grandparents who did the experiments with their grandchildren. A woman excitedly shared her childhood memories of an experiment. Teachers offered new experiments and variations.

People love science. You love science. Journalists take your work and tell people about it. So be kind to reporters–they're just sharing the love.

How to Succeed with the Media

Here's a short list of tips for dealing with the media, from me and the science writers of *The Oregonian*. You just have to remember four things:

- Be able to summarize the significance of your research in a sentence. Keep it simple and avoid jargon. Imagine that you are talking to a tipsy person at a noisy bar. Feel free to practice this on tipsy people in noisy bars. No, really, give it a try.
- Realize that newspapers have only limited space (and radio programs limited time). Don't give a reporter preprints of your last ten papers.
- Analogies are gold. Journalists need to simplify concepts, but it's easy to oversimplify and lose details. If you can supply an analogy or a simplified explanation, you can help ensure your findings are presented correctly.
- Respond to reporters as soon as you can–they may be working on a tight deadline. An hour or two can be the difference between making your voice heard and being too late.

–C.N.

Finding True Love in Carolina

By Zoe Buck

I was all about astrophysics for most of my life. I saw myself discovering new stars, spending long nights in the control rooms of great telescopes, and publishing esoteric tomes dedicated to the obscurer aspects of stellar structure or neutrino cosmology. I applied to only one university, Princeton, because of its astrophysics program, diving into the curriculum head first. But after spending my undergraduate years doing research science, it occurred to me that I wasn't having fun. Everything I loved about stars and planets was lost as I coded into the early hours of the morning and banged my head up against Einstein's field equations. This was not, as I had previously believed, my "thing."

As graduation loomed and I struggled to find my footing, the AAAS Mass Media Fellowship caught my eye. Science reporting seemed like a good blend of my strengths. I had a background in hard science and a passion for sharing things with people. Perhaps such a fellowship might reveal my "thing."

So there I was, in Raleigh, North Carolina, a city I had never visited, working in the newspaper industry, a medium I had absolutely no experience in.

The Raleigh News & Observer, where I had been placed, had no science, medicine or health reporter, so I took over all three beats immediately. My first byline appeared my third day at the paper, and I was soon pumping out published stories four or five times a week. I got to appear on the front page multiple times, and even got a few front page spreads. The readership was thrilled to have someone covering science, and they responded with letters, emails and phone calls. It only took about two weeks before I was hooked.

I was given fairly free reign, and reported on everything from a cutting edge dog prosthetic surgery at the local vet school to exciting developments in cancer research at one of many nearby universities. I reported on boobies who murdered their siblings, synthetic red blood cells, irrigation alternatives and polluted reservoirs. I got to talk to dozens of brilliant Raleigh scientists and doctors.

The journalists at the *News & Observer* were warm and welcoming. Having only a science background, I knew nothing of their lingo and craft, but they were eager to help. From them I quickly picked up the basics of reporting and a strong set of journalistic ethics. I was hoping to have an opportunity to stay at the newspaper, but unfortunately the economy and industry conspired against me, and the paper was unable to hire me.

It's a tough time to be falling in love with journalism of any kind, a fact I learned quickly at the *News & Observer*. While I was there 10% of the work force was laid off, with another chunk let go only weeks after I left. The rest of the newspaper industry is in a similar state.

Still, the AAAS Mass Media Fellowship definitely showed me my "thing." I love astrophysics and science, but more than doing it, I love to learn about it and tell people about it. I am currently working as an astronomy teacher at a non-profit science camp in California, and I am having a blast. This summer's experience allowed me to pinpoint what I love to do, and how I can make a difference in the public's understanding of science.

OLYMPIC continued from page 4

with another team event called laboratory football management, into a single contest. Winner is the professor with the most points accumulated during the contest.

Will Olympic Science be entertaining to watch? Or just painful? Will anyone be able to agree on what constitutes a good result, let alone a medal? Will America and China win all the medals or will smaller countries still claim glory? Tune in to the London 2012 Olympics to find out.

Duncan Hull is a postdoctoral research associate in biosciences and bioinformatics at the University of Manchester in England. The above originally appeared on his blog, O'Really. http://duncan.hull.name/2008/08/22/if-science-was-an-olympic-sport/

Putting Their Heads Together

Photo by Ken Cole

In August, APS Head of Public Outreach Jessica Clark (right) left for Vanderbilt University to pursue a career in medical physics. She had been leading the APS public outreach effort since its inception in 2000. Among her accomplishments were creating and maintaining the APS website for the public, PhysicsCentral; playing a major role in APS's leadership of the US activities during the World Year of Physics in 2005; and launching PhysicsQuest, a kit-based program with an adventure theme, aimed at middle-school students. Clark's successor is Becky Thompson-Flagg (left), who joined APS in January shortly after receiving her PhD in physics from the University of Texas at Austin, where she was also engaged extensively in outreach. Before taking over as Head of Public Outreach, Thompson-Flagg had been instrumental in creating the latest version of PhysicsQuest, built around the exploits of the Serbian physicist and inventor Nikola Tesla. In addition to her outreach activities, Thompson-Flagg is an accomplished tri-athlete and an expert in kung-fu. So don't mess with her.

Viewpoint...

Research and Education: Better Together

By Philip Zecher

Physical sciences research funded by the National Science Foundation and the Department of Energy have often overlapped and university-based research facilities have competed with the national labs for resources and talent. Normally, competition is a good thing that undoubtedly improves the quality of the research and bolsters US scientific preeminence. However, at least two trends threaten to turn a once-healthy competitive environment into a harmful fight for diminishing resources.

First, the overall resources available for research in the physical sciences has decreased dramatically over the last three decades, dropping nearly 50% in the last three decades as a percentage of GDP. Second, the inevitable consolidation caused by the increasing complexity and expense of leading edge research facilities means that fewer dollars are fighting for only a handful of bigger and more expensive projects.

University-based research labs have felt this constriction most acutely. For instance, throughout the 1960s and 1970s, there were many university laboratories with accelerators doing leading edge research in nuclear physics: MIT, SUNY, Harvard, Stonybrook, University of Rochester, Ohio University, Notre Dame, Cornell and Indian University, to name but a few. Today, of the five major facilities that dominate nuclear physics–the Argonne Tandem Linac Accelerator System (ATLAS), Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab, the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory, the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory, National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University, and the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory--only two are found on a university campus: the 88-Inch Cyclotron and the NSCL.

While the consolidation of research facilities may be inevitable, the move away from the university settings to the national labs is not, and it may come at a cost to US competitiveness. The 2006 National Academies of Science report, *Rising Above the Gathering Storm*, on how to prosper in the global economy of the 21st century, made the case that our economic future depends on education in science, engineering and mathematics. The third of its four recommendations declares that we should "make the US the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers…" This recommendation is undermined by the migration of research facilities out of universities and into the national labs, which are not first and foremost education facilities.

It is a matter of speculation whether an education, particularly a graduate education, that is physically removed from one's research equipment is any less desirable than an education where the research is done on campus. After all, few ecologists perform their research anywhere near their home institutions. But the pejorative term "suitcase science" has emerged to describe the work done by researchers who travel to national labs to run experiments, suggesting that this arrangement may be less than ideal. The best facilities generally attract and compete for the best researchers in the field. Once the facilities leave the campus, the human capital tends to follow, leaving students with fewer opportunities to inter-

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INSIDE THE BELTWAY
WASHINGTON ANALYSIS AND OPINION

Harry and Nancy

by Michael S. Lubell, APS Director of Public Affairs

Lately, as I've lain awake, troubled by my vanishing 401 (k) that now looks more like a shriveled prune than a juicy plum, I've been pondering how Senate Majority Leader Harry Reid and House Speaker Nancy Pelosi might be spending their congressional leave.

Reid is not up for office this year, and Pelosi comes from a safe San Francisco district, so neither has to press the flesh or talk the talk–at least not at home in Nevada or California. But I've never met a politician who wasn't vocally or visually narcissistic, so the odds are that both of them are never far from a microphone or camera.

Here's what I've imagined.

OPRAH: We're so fortunate to have two of our nation's political elite with us this afternoon, the Speaker of the House of Representatives, Nancy Pelosi, and the Majority Leader of the Senate Harry Reid. Help me welcome…

HARRY: Oprah, forgive me for interrupting, but we Democrats don't use the word "elite" to describe ourselves. Nancy and I represent the interests of the middle class.

OPRAH: I really didn't mean to offend. After all you know I've been campaigning for Barack Obama. I know that getting degrees from Columbia and Harvard, as he did, doesn't make him or anyone else with that pedigree an elitist.

NANCY: Let me just add that we Democrats remember what our roots are. We all come from immigrant families, and we identify with Main Street, not Wall Street

OPRAH: Madam Speaker…

NANCY: Oprah, just call me Nancy, it's much more plebeian, if I dare to use such an elitist word.

OPRAH: All right, then, Nancy, you said that as a Democrat you care more about Main Street than Wall Street. Is that why you had such difficulty passing the $700 billion financial bailout package? Do you think it's going to help Wall Street more than Main Street?

NANCY: Oh, no! I understand that liquidity is just as important for small business and the average person who wants to buy a car or a home. It's my constituents who don't–you know, the people who are just struggling to pay the rent, put food on the table…

HARRY: And pay those soaring medical bills, fill the tank and not have to freeze to death in the winter if you live in Minnesota or New England because you don't have enough money to pay for home heating oil.

OPRAH: Those are extraordinarily important issues, as I think everyone in the audience would agree. So why didn't Congress pass an energy bill this year or deal with the 45 million Americans going without medical insurance?

NANCY: Oprah, with the gridlock we faced, we couldn't even pass any spending bills, and that's the most important task Congress has every year–to keep the government running.

OPRAH: Last year you blamed President Bush for causing the problem. Is it still his fault?

HARRY: Nancy, let me answer that one. Oprah, we have only a one-vote majority in the Senate, and that's if you count Joe Lieberman, who lately has been a real thorn in my side. And we need 60 votes to get anything done in the Senate. So, to be honest, this year, with Republicans threatening to filibuster every bill, we just couldn't do much.

NANCY: And let me add that in the House, I have to deal with the "Blue Dogs," the fiscally conservative Democrats who made us adopt "pay-go" rules. You know we can't increase spending for any program unless we cut something else or raise taxes. There were all sorts of things we just had to put on hold. One of the things closest to my heart is science and innovation, and we just couldn't do anything about it.

OPRAH: Nancy, forgive me, but when it comes to innovation, you seem to be all talk. Your plan that's rapidly becoming a cruel myth called for about $10 billion over 10 years. This year–correct me if I'm wrong–you passed a $150 billion stimulus bill, a $170 billion supplemental appropriations bill and the $700 billion bailout. And Senator Reid…

HARRY: Just call me Harry.

OPRAH: Harry wasn't that bailout bill loaded with tens of billions of dollars worth of pork projects? Couldn't you have found a way to put in a measly $1 billion for science, since it is one of Nancy's favorite programs?

HARRY: It's one of mine, too, but, you know we tried and we just didn't have the votes.

OPRAH: So what about next year? Both of you expect to have larger Democratic majorities in Congress, and you're hoping to have a Democrat in the White House.

NANCY: Well, we're doing everything to make that happen, but the American people have the ultimate say. The problem is that even if we succeed, we will have to deal with the massive deficits we've been running the last eight years, and with a weak economy, we may just have to scale back our expectations. We may have to put science on hold for a few years.

OPRAH: Let's thank Harry and Nancy for being real.

Noyce Scholarships to Aid Selected Physics Teachers

By Gabriel Popkin

Photo by Gay Stewart/ University of Arkansas

Arkansas Noyce Scholar and future teacher Michael "Shane" Carey (center) works with undergraduates Stephen Brinson and Mark Blanko in an introductory physics class.

The APS and the American Association of Physics Teachers (AAPT) recently received a $750,000 award from the National Science Foundation (NSF) to provide Noyce Teacher Scholarships to approximately 30 future physics teachers over the next 5 years. These teachers, who will receive up to $15,000 of scholarship support per year for up to two years, will be selected from institutions participating in the PhysTEC project. PhysTEC is led by APS, AAPT, and the American Institute of Physics (AIP), with the goal of increasing the number of qualified high school physics teachers in the US.

Funding for the scholarships comes from the NSF's Robert Noyce Teacher Scholarship program, which is designed to support future science, technology, engineering, and math teachers. The Noyce program began in 2002, and as of Fall 2007 had supported approximately 1500 teachers from 91 institutions. For every year of scholarship support teachers receive, they commit to teach for two years in a "high-need" school district, which is defined as any district in which at least one school has a high proportion of low-income students or out-of-field teachers, or a high teacher turnover rate.

These criteria include a significant fraction of schools in the US, not just the most needy. According to Gay Stewart, a University of Arkansas physics professor and PhysTEC site leader who also administers an independent Noyce project, "the problems of teacher turnover and out-of-field teaching are so widespread, especially in science, that my Noyce teachers are easily able to find qualified high-need schools to work in.".

"The Noyce scholarships allow my students to spend their time learning to teach instead of working or worrying about loans" Stewart says. "We have an award-winning Master of Arts in Teaching program, but it is full time, and students don't get support or have time to work. We should not ask our students to choose teaching over higher-paying professions, and then tell them they need to go into debt to become a teacher." Arkansas awarded 17 Noyce scholarships—including 7 to future physics teachers—in 2007-2008, its first year of Noyce funding.

The PhysTEC Noyce project will award scholarships to teachers from Ball State University, Cornell University, Seattle Pacific University, the University of Arkansas, the University of North Carolina, and Western Michigan University. Along with Arkansas, PhysTEC sites Seattle Pacific, University of Arizona, and University of Colorado at Boulder already run Noyce programs that provide scholarships to some of their science teachers, and the project is poised to take advantage of the expertise these sites have gained.

In addition, PhysTEC institutions Cal Poly San Luis Obispo, Florida International University, and the University of Minnesota have all received independent Noyce awards during this round of funding, which will also support teachers in multiple science disciplines.

According to NSF Program Officer Joan Prival, the PhysTEC Noyce award is the first to focus on a single science discipline, as well as the first given to a professional society. Monica Plisch, APS assistant director of education and principal investigator, explains that "by pooling applicants from multiple universities, APS and AAPT are able to award these scholarships entirely to future physics teachers, who are the hardest teachers for schools to hire in any math and science field. We are especially excited that the PhysTEC Noyce project will allow us to place teachers in the underserved communities where they are needed the most."

More information about PhysTEC can be found at www.PhysTEC.org.

MGM Recipients Achieve MacArthur Trifecta

Andrea Ghez, an astrophysicist at UCLA who received the APS Maria Goeppert Mayer (MGM) award in 1999, is among the recipients of the MacArthur Fellowship for 2008. This year's MacArthur fellows were announced in September.

The MacArthur fellowships, commonly called "genius grants," give recipients $500,000 with no restrictions on how the money is spent. Recipients come from a range of disciplines, including art, science, social science, education, business, medicine, and many others. This year there are several physicists among the recipients. MacArthur fellows are chosen for their creativity, originality, and promise for important future advances based on a record of accomplishment.

The MGM award is intended to recognize and enhance outstanding achievement by a woman physicist in the early years of her career, not later than ten years after the granting of the PhD degree. It recognizes scientific achievements that demonstrate potential as an outstanding physicist.

Ghez uses ground-based telescopic techniques to identify thousands of new star systems and illuminate the role of super-massive black holes in the evolution of galaxies. She is the third MGM award recipient to go on to win a MacArthur grant. The others are Deborah Jin and Margaret Murnane. Jin, of JILA (an institute of the University of Colorado), researches novel quantum systems including degenerate Fermi gases, and Murnane, also now of JILA, works in experimental ultrafast optical physics. Jin won the MGM award in 2002; Murnane won the MGM award in 1997.

Other MGM award recipients have gone on to be elected to the National Academy of Sciences and win many other honors.

The MGM award is given to early career physicists who demonstrate potential, noted Sue Otwell, APS women's programs administrator. The fact that so many of these women have become extremely successful physicists is a sign of promise fulfilled, she said.

NUCLEAR continued from page 1

toward addressing that challenge include creating an international fuel bank, developing advanced technical safeguards and closing a loophole in the nonproliferation treaty, the study suggests.

Opinions differ on the importance of nuclear weapons for security. Study group participants generally agreed that the US needs a credible nuclear deterrent.

Refurbishing and updating the nuclear stockpile and infrastructure as necessary without creating any new nuclear weapon capabilities could increase confidence in the reliability of our nuclear weapons, thereby making it possible to reduce the total inventory while maintaining a credible nuclear deterrent, the report states. The report recommends using a "spectrum of options" to refurbish and update the stockpile, considering each system on an individual basis. There is no immediate need to commit to any particular program, the report states. The nuclear weapons laboratory directors continue to certify annually the current stockpile as safe, reliable and secure.

"In this approach, the president will be assured that our deterrent force is safe, secure and reliable as long as it is needed, regardless of its size. This would enable new efforts to engage other nations in reducing global arsenals and strengthening efforts against nuclear terrorism," said Browne.

To maintain a credible nuclear deterrent the US also needs to sustain the necessary human capital, the report says, expressing the concern that "expertise and competence is declining across the nuclear enterprise." A broader mission for the nuclear weapons labs to include energy and nuclear security can help recruit scientists and engineers, the report recommends.

"The next step after the release of our report is to discuss these issues with appropriate audiences within the government, the defense and scientific communities, hopefully to stimulate action in the next administration," said Browne.

ANNOUNCEMENTS

APS CONGRESSIONAL SCIENCE FELLOWSHIP 2009-2010

THE AMERICAN PHYSICAL SOCIETY is currently accepting applications for the Congressional Science Fellowship Program. Fellows serve one year on the staff of a senator, a representative or of a congressional committee. They are afforded an opportunity to learn the legislative process and explore science policy issues from the lawmakers' perspective. In turn, Fellows have the opportunity to lend scientific and technical expertise to public policy issues.

QUALIFICATIONS include a PhD or equivalent in physics or a closely related field, a strong interest in science and technology policy and, ideally, some experience in applying scientific knowledge toward the solution of societal problems. Fellows are required to be US citizens and members of the APS.

TERM OF APPOINTMENT is one year, beginning in September of 2008 with participation in a two-week orientation sponsored by AAAS. Fellows have considerable choice in congressional assignments.

A STIPEND is offered in addition to allowances for relocation, in-service travel, and health insurance premiums.

APPLICATION should consist of a letter of intent of no more than 2-pages, a 2-page resume with one additional page for publications, and three letters of reference. **Please see the APS website** (http://www.aps.org/policy/fellowships/congressional.cfm) for detailed information on materials required for applying and other information on the program.

ALL APPLICATION MATERIALS MUST BE SUBMITTED ONLINE BY JANUARY 15, 2009.

Physics Bachelor's and PhDs Continue to Trend Upward

The number of physics bachelor's degrees has increased for the seventh straight year, according to a recent report from the American Institute of Physics Statistical Research Center.

The report, released in September, is based on an annual survey of physics departments in the US. This year's report contains data on the class of 2006, the most recent year for which data are available.

In 2006, according to the report, 5373 bachelor's degrees were awarded, five percent more than the previous year, and 47% more than in 1999.

Some of the increase in physics bachelors is accounted for by the increase in college age population and the increased number of people attending college, the report notes. Efforts to improve the undergrad experience for physics majors and efforts to increase number of physics bachelor's degrees may also be having an effect, but that is difficult to measure, the report says.

Though numbers are increasing, physics bachelor's degrees represent only one third of one percent of all bachelor's degrees, and only about 2% of all bachelor's degrees in the natural sciences, mathematics, and engineering.

About 15% of physics bachelors eventually receive a PhD in physics. About a third of physics bachelor's degree recipients immediately enroll in physics graduate school, the report notes.

Physics PhD production was also up, with 1380 physics PhDs awarded in 2006. This is an increase of 11 percent from the year before and 26 percent from 2004. It amounts to 3% of all PhDs conferred in the United States.

The report also noted that there are 760 departments that offer a physics degree, and 187 of those offer a PhD as the highest degree. During the 2005-2006 academic year, 378,000 students took an introductory physics course.

In the fall of 2006, there were 2976 first year graduate students enrolled in physics PhD programs. International students continue to make up a substantial portion of new physics graduate students, making up more than 40 percent of first year students in the fall of 2006. However, this proportion is decreasing; more than fifty percent of first year physics graduate students were foreigners five years earlier. The proportion of physics PhDs awarded to foreigners in 2006 was 57 percent, down from a high of 60 percent the year before. Similar to recent years, foreign citizens made up only 7 percent of physics bachelor's degree recipients.

The proportion of women among physics bachelor's degree recipients was the same as the previous year, 21%, and is still among the lowest in the natural sciences and engineering. Women earned 17% of physics PhDs in 2006. As in previous years, underrepresented minorities continue to make up only a very small portion of physics degree recipients. Historically black colleges and universities (HBCUs) still produce more than half of the African American physics bachelor's degree recipients.

The report, and more information from the AIP Statistical Research Center, is online at aip.org/statistics.

Job Fairs

Looking for a job?

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APS Division of Plasma Physics

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Now Appearing in RMP: Recently Posted Reviews and Colloquia

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

Attosecond physics

Ferenc Krausz and Misha Ivanov

Experimental tools and techniques for observing and steering electronic dynamics on the atomic scale are becoming available. Recent progress in attosecond physics has far reaching implications not only for physics but also biology and chemistry. This article addresses the key concepts and experimental tools which provide the means of observing and controlling the atomic-scale motion of electrons in real time, the theoretical models critical for connecting experimental observables with microscopic variables, and some expected implications of this revolution in technology.

Professional Skills Development for Women Physicists

Do you want *to improve your negotiation skills?*

Do you have *great ideas that you want to communicate to your colleagues?*

If so, the **Committee on the Status of Women in Physics** invites you to attend one of the workshops entitled "Professional Skills Development for Women in Physics." These workshops will:

- Coach women in key skills that are needed to enhance their careers.
- Provide training in persuasive communication, negotiation, and leadership presented by experienced professionals, with an aim towards increasing the influence of female physicists within their own institutions.
- Provide a special opportunity for networking among participants.

Workshops in 2009 will each have one session aimed at women post-docs in physics and one session aimed at tenured women faculty in physics. Workshops will be offered on **Sunday, March 15** (Pittsburgh) and on **May 1** (Denver) in association with the APS national meetings.

The deadline to apply for the March workshop is December 5, 2008; the deadline to apply for the April workshop is January 5, 2009. First consideration will be given to applications received by the deadlines. Women of color are especially encouraged to apply.

Workshops will be limited in size for optimal benefits. Participants are eligible to receive a stipend to help cover the cost of travel and up to two nights lodging.

Details at www.aps.org/programs/women/workshops/skills/index.cfm

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act with the diverse leaders in their field and potentially diminishing their education.

The migration of new facilities to the national labs is in part due to a shift in nuclear physics funding from the NSF to the DOE. In constant dollar terms, the NSF nuclear physics budget has declined in the last 20 years while the DOE's component of combined budgets allocated to nuclear physics has increased from 85% in 1989 to 90% in 2008. As the DOE picks up more of the nuclear physics research tab, it must choose to allocate its resources between universities and the national labs, and as evidenced by the list of major nuclear physics facilities, the trend is clear.

The question of the DOE's role in providing research facilities is nothing new. In a 1992 report, delivered to the senior President Bush by then director of the Office of Science and Technology Policy, D. Allan Bromley of Yale, the issue of the federal laboratories is explicitly raised, declaring that "because federal support for research intensive universities is affected by agency commitments to federal laboratories, PCAST believes there is now an urgent need to reexamine the roles of the more than seven hundred federal laboratories."

Sixteen years later, this question of national policy has not been addressed and again manifests itself in the current competition between a university and the DOE. The remaining, fully university-based nuclear physics facility among the five major facilities, the NSCL, is competing with Argonne for the contract to build the next generation rare-isotope laboratory, the Facility for Rare Isotope Beams (FRIB). All parties agree that this competition should be decided on the merits of each proposal, but in stark contrast to the DOE's stated goal of "training the next generation of scientists," it has declared that it will not consider any educational benefits that might result from integrating FRIB into MSU when evaluating MSU's proposal.

The *Renewing the Promise* report went on to address directly the different merits that should be considered for federal funding. "It is appropriate to consider making all federal basic research support available for merit-based competition by universities, federal laboratories, or industry. Merit review in this case should include, as additional criteria, potential long-term contributions to economic well-being, national security, and education."

Many of our top research universities are under tremendous financial pressure and when they compete for federal research dollars, if their biggest asset, the education of our future scientific leaders, is not to be considered, can we expect to "make the United States the most attractive setting in which to study and perform research?" US universities will not remain magnets for talent if the most powerful tools to perform research are located elsewhere.

Philip Zecher is a partner, and Chief Risk Officer, of EQA Partners, LP, of Stamford, CT. He holds a PhD in nuclear physics from Michigan State University.

The Back Page

The Future of Science: Building a Better Collective Memory

By Michael A. Nielsen

When Robert Hooke discovered his law of elasticity in 1676, he didn't publish it in the ordinary way. Instead, he published it as an anagram: "ceiiinosssttuv." He revealed this two years later as the Latin *ut tensio, sic vis*, meaning "as the extension, so the force." This ensured that if someone else made the same discovery, Hooke could reveal the anagram and claim priority, thus buying time in which he alone could build upon the discovery.

Many great scientists of the age, including Leonardo, Galileo and Huygens, used anagrams or ciphers for similar purposes. The Newton-Leibniz controversy over who invented calculus occurred because Newton claimed to have invented calculus in the 1660s and 1670s, but didn't publish until 1693. In the meantime, Leibniz developed and published his own version of calculus.

Such secrecy was natural in a society in which there was often little personal gain in sharing discoveries. This secrecy faded because the great scientific advances in the time of Hooke and Newton motivated wealthy patrons such as the government to begin subsidizing science as a profession. Because the public benefit delivered by scientific discovery was strongest if discoveries were shared, the result was a scientific culture that to this day rewards the sharing of discoveries. Today, when a scientist applies for a job, the most important part of the application is often their published scientific papers.

The adoption and growth of the scientific journal system has created a body of shared knowledge for our civilization, a collective long-term memory that is the basis for much of human progress. This system has changed surprisingly little in the last 300 years. The Internet offers us the first major opportunity to improve this collective long-term memory, and to create a collective short-term working memory, a conversational commons for the rapid collaborative development of ideas.

One way of viewing online tools is as a way of expanding the range of scientific knowledge that can be shared with the world. A successful example is the physics preprint arXiv, which lets physicists share preprints of their papers without the months-long delay typical of a conventional journal. More radically, the internet can also change the process and scale of creative collaboration, using social software such as wikis, online forums, and similar tools. I believe that such tools and their descendants will change scientific collaboration more over the next 20 years than it has changed in the past 300 years. Yet, with the exception of email, scientists currently appear puzzlingly slow to adopt many online tools. This is a consequence of some major barriers deeply embedded within the culture of science.

Two Failures of Science Online

Inspired by the success of Amazon.com's review system and similar sites, many organizations have created comment sites where scientists can share their opinions of scientific papers. Perhaps the best-known was *Nature's* 2006 failed trial of open commentary on papers being peer reviewed at *Nature*. To date, none of the sites have succeeded.

The problem is that while thoughtful commentary on scientific papers is useful for other scientists, there are few incentives for people to write such comments. Why write a comment when you could be doing something more "useful," like writing a paper or a grant? Furthermore, if you publicly criticize someone's paper, there's a chance that person may be an anonymous referee in a position to scuttle your next paper or grant application.

Contrast this with the approximately 1500 reviews of Pokemon you'll find at Amazon.com. We have a ludicrous situation where popular culture is open enough that people feel comfortable writing Pokemon reviews, yet scientific culture is so closed that people will not publicly share their opinions of scientific papers. Some people find this curious or amusing; I believe it signifies something seriously amiss with science that needs to change.

Wikipedia is a second example where scientists have missed an opportunity to innovate online. Wikipedia has a vision statement to warm a scientist's heart: "Imagine a world in which every single human being can freely share in the sum of all knowledge. That's our commitment." You might guess Wikipedia was started by scientists eager to collect all of human knowledge into a single source. In fact, Wikipedia's founder, Jimmy Wales, had a background in finance and as a web developer. In the early days few established scientists were involved. To contribute would arouse suspicion from colleagues that you were wasting time that could be spent writing papers and grants.

Some scientists will object that contributing to Wikipedia isn't really science. It's not if you take it for granted that science is only about publishing in specialized scientific journals. But if you believe science is about discovering how the world works, and sharing that understanding with the rest of humanity, then the lack of early scientific support for Wikipedia looks like an opportunity lost. Nowadays, Wikipedia's success has to some extent legitimized contribution within the scientific community. But how strange that the modern day Library of Alexandria had to come from outside academia.

An Open Scientific Culture

The value of openness was understood centuries ago by many of the founders of modern science; indeed, the journal system is perhaps the most open system for the transmission of knowledge that could be built with 17th century media. The adoption of the journal system was achieved by subsidizing scientists who published their discoveries in journals. This same subsidy now *inhibits* the adoption of more effective technologies.

We should aim to create an open scientific culture where as much information as possible is moved out of people's heads and labs, onto the network, and into tools that can help us structure and filter the information: data, scientific opinions, questions, ideas, folk knowledge, workflows, and everything else. Information not on the network can't do any good.

One way to achieve cultural change is via the top-down strategy that's been successfully used by the open access (OA) movement. The goal of OA is to make scientific research freely available online to everyone in the world. In April 2008 the National Institutes of Health mandated that every paper written with the support of their grants must eventually be made open access. This is the scientific equivalent of successfully storming the Bastille.

The second strategy is bottom-up. It requires that the people building the new online tools also develop and boldly evangelize ways of measuring the contributions made with the tools. As an example, since 1991 physicists have been uploading their papers to the physics preprint arXiv, often at about the same time as they submit to a journal. The arXiv is not refereed, although a quick check is done by arXiv moderators to remove crank submissions. In many fields, most papers appear on arXiv first, and many physicists start their day by seeing what's appeared on the arXiv overnight.

After the arXiv began, a service for particle physics called SPIRES-HEP extended their citation tracking to include both arXiv papers and conventional journal articles. As a result, it's now possible to search on a particle physicist's name, and see how frequently all their papers, including arXiv preprints, have been cited by other physicists.

SPIRES-HEP has been run since 1974 by the Stanford Linear Accelerator Center (SLAC). SLAC's metrics of citation impact are both credible and widely used by the particle physics community. When physics hiring committees meet to evaluate candidates in particle physics, people often have their laptops out, examining and comparing the SPIRES-HEP citation records of candidates. The result is a small but genuine cultural change towards more openness in science, achieved using the bottom-up strategy.

The Problem of Collaboration

When doing research, subproblems constantly arise in unexpected areas. No one can be expert in all those areas. Most of us instead stumble along, picking up the skills necessary to make progress towards our larger goals. We have a small group of trusted collaborators with whom we exchange questions and ideas when we are stuck. They may point us in the right direction, but rarely do they have exactly the expertise we need. Might it be possible to use online tools to scale up this conversational model, and build an online collaboration market to exchange questions and ideas, a sort of collective working memory for the scientific community?

To see how much is lost due to inefficiencies in the current system of collaboration, imagine a scientist named Alice. Many of Alice's research projects spontaneously give rise to problems in areas in which she isn't expert. Suppose that for a particular problem, Alice estimates that it would take her four to five weeks to acquire the required expertise and solve the problem. So the problem is on the backburner. Unbeknownst to Alice, though, there is another scientist in another part of the world, Bob, who has just the skills to solve the problem in less than a day.

Unfortunately, nine times out of ten they never even meet, or if they do, they just exchange small talk. It's an opportunity lost for a mutually beneficial trade, a loss that may cost weeks of work for Alice. It's also a great loss for the society that bears the cost of doing science. Expert attention, the ultimate scarce resource in science, is very inefficiently allocated under existing practices for collaboration.

An efficient collaboration market would enable Alice and Bob to find this common interest, and exchange their know-how, in much the same way eBay and craigslist enable people to exchange goods and services. However, in order for this to be possible, a great deal of mutual trust is required. Without such trust, there's no way Alice will be willing to advertise her questions to the entire community.

Let's compare this situation to the apparently very different problem of buying shoes. Alice walks into a shoe store, with some money. Alice wants shoes more than she wants to keep her money; Bob the shoe store owner wants the money more than he wants the shoes. As a result, Bob hands over the shoes, Alice hands over the money, and everyone walks away happier after just ten minutes. This rapid transaction takes place because there is a trust infrastructure of laws and enforcement in place that ensures that if either party cheats, they are likely to be caught and punished.

If shoe stores operated like scientists trading ideas, first Alice and Bob would need to get to know one another, maybe go for a few beers in a nearby bar. Only then would Alice say, "You know, I'm looking for some shoes." After a pause, and a few more beers, Bob would say "You know what, I just happen to have some shoes I'm looking to sell." Every working scientist recognizes this dance; I know scientists who worry less about selling their house than they do about exchanging scientific information.

In economics, it's been understood for hundreds of years that wealth is created when we lower barriers to trade, provided there is a trust infrastructure of laws and enforcement to prevent cheating and ensure trade is uncoerced. The basic idea, which goes back to David Ricardo in 1817, is to concentrate on areas where we have a comparative advantage, and to avoid areas where we have a comparative disadvantage.

Ricardo's analysis works equally well for trade in ideas. Indeed, even were Alice to be far more competent than Bob, both Alice and Bob benefit if Alice concentrates on areas where she has the greatest comparative advantage, and Bob on areas where he has less comparative disadvantage. Unfortunately, science currently lacks the trust infrastructure and incentives necessary for such free, unrestricted trade of questions and ideas.

An ideal collaboration market will enable just such an exchange of questions and ideas. It will bake in metrics of contribution so participants can demonstrate the impact their work is having. Contributions will be archived, timestamped, and signed, so it's clear who said what, and when. Combined with high quality filtering and search tools, the result will be an open culture of trust that gives scientists a real incentive to outsource problems, and contribute in areas where they have a great comparative advantage, fundamentally changing how science is done.

Michael Nielsen is a writer working on a book about the future of science. For information about the book, see http://michaelnielsen.org/blog/?page_id=467. In a past life he helped pioneer the field of quantum computation, and was the author of more than 50 scientific papers. The above article is adapted from an essay appearing on his blog, based on his keynote talk at the New Communication Channels for Biology workshop, San Diego, June 26 and 27, 2008. The full version can be found at http://michaelnielsen.org/blog/?p=448.