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Econophysics and the Current Economic Turmoil
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Pittsburgh Steels Itself for Physics Invasion

The 2009 APS March Meeting will be held March 16-20 in Pittsburgh, Pennsylvania. It is the largest annual gathering of professional physicists in the country. This year the scientific program will feature 112 invited sessions and 462 contributed sessions (574 total sessions), at which approximately 7000 papers will be presented, covering the latest research in areas represented by the APS divisions of Atomic, Molecular and Optical Physics; Biological Physics; Chemical Physics; Computational Physics; Condensed Matter Physics; Fluid Dynamics; Laser Science; Materials Physics; Physics of Beams; and Polymer Physics.

Also taking part will be the APS topical groups on Instrument and Measurement Science, Magnetism and its Applications, Statistical and Nonlinear Physics, and Quantum Information, as well as the forums on Industrial and Applied Physics, Physics and Society, History of Physics, International Physics, Education, and Graduate Student Affairs.

Special scheduled events include the annual prize and award presentation, a panel discussion with APS journal editors, a students' lunch with the experts, and a High School Teachers' Day.

In addition to the regular technical program, there will be eight half-day tutorials offered on Sunday, March 15. The tutorial topics are: Bose-Einstein Condensation and Degenerate Fermi Gases; Graphene; Plasmonics; Terahertz Spectroscopy and Its Applications; Spintronics: Physics and Device Applications; Emergent Phenomena in Complex Oxides; Nanomagnetism; Advances in Josephson Qubits.

A one-day workshop on Opportunities in Energy Research for graduate students and postdocs will be held Sunday, March 15.

The 6th APS Workshop on Opportunities in Biological Physics, organized by the Division of Biological Physics, will be held on Sunday, March 15.

On Saturday, March 14 and Sunday, March 15, the Division of Polymer Physics will host a special short course: Physics of Polymer Nanocomposites. There will also be a professional skills development workshop for women physicists, and a joint APS department of education/Forum on Education workshop on Incorporating Simulations and Computer Modeling into Upper Level Physics Courses.

Child-care grants of up to $300 will be available to assist meeting attendees bringing small children. The application form is available on the meeting website. A parent-child quiet room will also be available.

More info about the meeting can be found at: www.aps.org/meetings/march/index.cfm.

Apker Recipients Study Graphene, Quantum Information Theory

The LeRoy Apker Award is given for outstanding research accomplishments in physics by an undergraduate. Two categories are recognized, one for an undergraduate at an institution that grants the PhD, and the other for an undergraduate at an institution that does not grant the PhD. As reported in last month's *APS News*, the selection committee first picks a number of finalists from each category, who then meet for a day of interviews with the committee before the recipients are chosen.

Sujit Datta

Byron Drury

This year's recipient in the PhD category is Sujit Datta of the University of Pennsylvania. Working in the lab of Alan (Charlie) Johnson, he conducted his senior thesis research on nanoscale physics, primarily the properties of graphene. He used scanning probe microscopy to show how the surface potential of few-layer graphene sheets depends on the number of layers. Datta is now pursuing his PhD as a graduate student at Harvard.

The recipient in the non-PhD category is Byron Drury of Haverford College. His senior-year research, conducted under the supervision of Peter Love, was in the area of quantum information theory. He used elegant Lie Algebraic techniques to factorize general n-qubit operations into a product of elementary unitary operators that act on only one or two qubits. Drury was awarded a Churchill Scholarship, with which he is spending a year at Cambridge University before pursuing his PhD at MIT.

Sigma Pi Sigma Congress Convenes at Fermilab

By Nadia Ramlagan

With the end of the 2008 US presidential election just a few days prior, the topic of scientific citizenship discussed at this year's Sigma Pi Sigma Quadrennial Congress seemed especially relevant. Five hundred and fifty students representing 103 institutions gathered at Fermilab in Batavia, IL this year to explore the myriad ways scientists effect change in society, from local activism to national politics.

Sigma Pi Sigma is a national physics honor society, housed within the Society of Physics Students (SPS). Both are administered by the American Institute of Physics. The Congress, held November 6-8, was designed to bring together undergraduates, physics alumni, and practicing physicists. The APS and the American Association of Physics Teachers provided some support for the Congress.

"Our collective task, by the very nature of our gathering, is to ask what we can resolve to do as a society to best prepare the physicists of tomorrow. How shall we best encourage scientific citizenship?" remarked planning committee members Michael Gaither and Justin Stimatze at the opening of the Congress.

Participants tackled issues like science funding and policy, public perception of science, international research and collaboration, diversity in scientific fields, and science education and outreach through a series of scientific citizenship workshops. During roundtable brainstorming sessions, members formulated recommendations to enhance the Society's role in the civic science movement. Chapters voted on several recommendations, which will be encapsulated into a subset of actionable ideas and eventually implemented.

Many attendees expressed surprise at the notion of scientists getting involved "in politics" and making a difference in their communities. "Before this conference, I didn't know that as a physicist I could have a career in politics. It

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April Meeting Plenary Speakers Set

Speakers have been set for the plenary lectures at the 2009 APS April Meeting, which, despite its name, will be held May 2-5 in Denver, Colorado. The theme of the 2009 April Meeting is "New Eyes on the Universe: 400 Years of Telescopes." The plenary lectures will be exciting and informative, featuring a broad range of distinguished speakers. More information about the April Meeting is online at http://www.aps.org/meetings/april/index.cfm .

Saturday, May 2
8:30 a.m.–10:30 a.m.

Peter Michelson, Stanford University, *First results from Fermi/GLAST*

Kent Paschke, University of Virginia, *What have we learned using the CEBAF microscope to study hadronic matter?*

Joan Centrella, NASA/Goddard, *Merging black holes*

Monday, May 4
8:30 a.m.–10:30 a.m.

Alexander Zholent, LBNL, *Next generation microscopes for the study of matter*

Robert Rosner, Argonne National Laboratory, *Nuclear Energy*

Richard Muller, University of California, Berkeley, *A physicist evaluates the terrorist threat*

Tuesday, May 5
8:30 a.m.–10:30 a.m.

Paris Sphicas, University of Athens, Greece, *The LHC*

James Cronin, University of Chicago, *Nature's highest energy messenger: Pierre Auger Observatory*

Raymond Fonck, University of Wisconsin–Madison, *Recent Highlights in Plasma Physics on the Path to ITER*

SESAME Now Officially Open

SESAME, a synchrotron radiation laboratory in the Middle East, opened with an inauguration ceremony November 3, attended by Prince Ghazi ben Mohammad of Jordan and Director-General of UNESCO Koichiro Matsura.

SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East) is a UNESCO-sponsored project that aims to promote scientific development as well as understanding and cooperation among scientists from different countries in the Middle East.

The facility is located in Allaan, Jordan, about 20 miles from Amman. The November ceremony marked the completion of the main building for SESAME. Scientific operations are expected to begin in 2011.

The SESAME project will offer facilities for interdisciplinary scientific collaboration and promote basic and applied research in the Middle East.

Photo courtesy of SESAME

Jordanian Prince Ghazi ben Mohammed (left) watches as Koichiro Matsura (right), Director-General of UNESCO, cuts the ribbon signifying the launch of the SESAME facility. Standing between them is the Director of SESAME, Khaled Toukan.

"One of the challenges for the success of SESAME is building a user community by enabling Middle

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Members in the Media

"What we have done is we have put together two materials, neither of which is a superconductor, and we found their interface–where they touch–is superconducting,"

***Ivan Bozovic**, Brookhaven National Laboratory,* Reuters*, October 8, 2008*

"We've got a lot of money on the table (for science spending). The question is how to spend it. That is going to be the question for the next administration. That is going to be tough."

*Presidential Science Advisor **Jack Marburger**,* Associated Press*, October 16, 2008*

"Scientifically, it is a compelling problem, and the public accepts the notion that it's a problem. But at the moment most people are feeling affected by other things in a much more urgent fashion."

***Michael Lubell**, APS, on climate change,* St. Louis Post-Dispatch, *October 22, 2008*

"The core message is we need a comprehensive energy strategy. Nuclear energy can and should be a part of that overall comprehensive energy strategy, but nothing can happen without the human resources."

***Shirley Jackson**, Rensselaer Polytechnic Institute,* Associated Press*, October 6, 2008*

"Some kind of microscopic lightning effect."

***Seth Putterman**, UCLA, on how scotch tape generates x-rays when unrolled,* The New York Times*, October 23, 2008*

"An electromagnetic cloak could bend light around itself, similar to the flow of water around a stone, making invisible both the cloak and an object hidden inside."

***Vladimir M Shalaev,** Purdue University,* The Toronto Star*, October 25, 2008*

"I just felt sick in my heart. They went out with their dredges to San Bruno Shoal and piled up millions and millions of tons. They changed the whole hydraulics of the bay."

***Ralph Nobles**, on development of wetlands around the San Francisco Bay,* San Jose Mercury News*, October 24, 2008*

"Some of my favorite days are when I get to see students learning something new. I especially enjoy the opportunities that physics affords me to think deeply about all kinds of things, from the trivial to the profound, and I also enjoy the chance to implement new programs and ideas that benefit young people."

***Gary White**, AIP, T*he Topeka Capital-Journal*, October 13, 2008*

"Having something that you can hold in your hand is an accomplishment in nanotechnology."

***Wade Adams**, Rice University, on "buckypaper," which researchers at Florida State are beginning to commercialize,* Associated Press*, October 17, 2008*

"On the one hand, a head-first slide gets the fingertips to the bag before the center of mass gets there. On the other hand, sliding reduces your forward velocity. As with many things in physics, it is not so obvious which effect wins out."

***Alan Nathan**, University of Illinois at Urbana-Champaign, on whether baseball players should slide or run to the base,* HealthDay News*, October 21, 2008*

"The snail has to figure out how to apply the right force– you have to tune yourself to exploit this 'sweet spot' of surface tension. If you're doing too much or too little, it won't work."

***Eric Lauga**, UC San Diego, on his study of how water snails move,* MSNBC.com*, November 3, 2008*

"We cannot explain [the effect] 100%, but it gives us a new mechanism, and probably new science, to focus on as we try to raise the efficiency of thermoelectrics,"

***Mercouri Kanatzidis,** Northwestern University, on a new more efficient thermoelectric material,* The Guardian*, October 13, 2008*

"The people got an opportunity to see who I was."

***Bill Foster,** on winning re-election to Congress,* Chicago Sun-Times*, November 5, 2008*

"If you hit something, what's stopping you from putting your hand through it is electromagnetism. That's much stronger than the force pulling it down to the ground."

***Glenn Starkman**, Case Western Reserve University, on the weakness of gravity compared to other forces,* The Cleveland Plain Dealer, *November 5, 2008*

This Month in Physics History

December 1706: Birth of Émilie du Châtelet

Émilie du Châtelet, famous for being Voltaire's mistress, was actually a talented scientist and intellectual in her own right. Overcoming challenges that kept women from becoming scientists at the time, she educated herself and carried out experiments in physics, and completed a translation and commentary on Newton's *Principia*.

Gabrielle Émilie le Tonnelier de Breteuil (later Émilie du Châtelet), was born December 17, 1706 in Paris. Her father, Louis Nicolas le Tonnelier de Breteuil, was a high ranking official of the court of Louis XIV. The de Breteuil family was part of French aristocratic society, and as such they entertained often. Distinguished scientists and mathematicians were frequent visitors to the household.

Educated at home, the young Émilie learned to speak six languages by the time she was twelve, and had lessons in fencing and other sports. Even from a young age she was fascinated most by science and math, much to her mother's displeasure. Such interests were not viewed as proper for young ladies, and her mother even threatened to send her away to a convent. Fortunately, her father recognized her intelligence and encouraged her interests, arranging for her to discuss astronomy with prominent scientists he knew.

Émilie also had a flair for gambling, applying her talent at mathematics to give herself an advantage. She used her winnings to buy books and laboratory equipment for her scientific investigations.

When she reached age 18, she knew she had to get married, and she accepted the proposal of Marquis Florent-Claude du Châtelet, a distinguished army officer. This was a convenient arrangement for Émilie, because Châtelet was often away from home, leaving her free to indulge her interests in studying math and science on her own.

She was also free to carry on an affair with the writer Voltaire, one of the few men who appreciated her intelligence and encouraged her scientific pursuits. Émilie du Châtelet and Voltaire renovated Châtelet's large estate house in the countryside. The house included several rooms for scientific equipment and space for experiments, and a large library holding over 20,000 books, more than many universities at the time.

Although she was frustrated at being excluded from scientific society and education because she was a woman, she was able to learn mathematics and science from several renowned scholars, including Pierre-Louis Maupertuis and Samuel Konig, by inviting them to her house.

In 1737, after several months of conducting research in secret, she entered a contest sponsored by the French Academy of Sciences on the nature of light, heat and fire, submitting her paper *Dissertation sur la nature et la propagation du feu.* In it she suggested that different colors of light carried different heating power and anticipated the existence of what is now known as infrared radiation. She did not win the contest, but her paper was published and was positively received by the scientific community.

She also developed a strong interest in the work of Isaac Newton, which was somewhat controversial at the time in France, where Cartesian philosophy was favored over Newton's ideas. Émilie and Voltaire jointly wrote a book, *Elements of Newton's Philosophy*, which explained Newton's astronomy and optics in a clear manner for a wide French readership. Only Voltaire's name appeared on the book, but he acknowledged her important role.

Émilie also worked on another manuscript, *Foundations of Physics*, in which she considered the philosophical basis of science and tried to integrate the conflicting Newtonian, Cartesian, and Leibnizian views.

One of her most important contributions to science was her elucidation of the concepts of energy and energy conservation. Following experiments done earlier by Willem 's Gravesande, she dropped heavy lead balls into a bed of clay. She showed that the balls that hit the clay with twice the velocity penetrated four times as deep into the clay; those with three times the velocity reached a depth nine times greater. This suggested that energy is proportional to mv^2, not mv, as Newton had suggested.

While conducting her scientific work, Émilie du Châtelet still carried out her duties as a mother to her three children and as a hostess for her many visitors so she was always busy, and had little time for sleep.

At age 42 Émilie du Châtelet discovered she was pregnant. At that time, a pregnancy at such an old age was extremely dangerous. Knowing she would likely die, she began working 18 hours a day to complete her biggest project, a French translation of Newton's *Principia*, before she died.

More than simply a translation, Émilie du Châtelet's *Principia* included her own notes, examples, derivations, and clarifications of Newton's often obscure writing, as well as examples of experiments that confirmed Newton's theories. Her modern notation and clear style soon helped French scientists understand and build upon Newton's ideas.

With determined effort, she achieved her goal of finishing the manuscript just before she died in September 1749. The complete work was published ten years later, when the return of Halley's Comet brought about a renewed interest in Newtonian mechanics.

Émilie du Châtelet's book was for many years the only available translation of Newton's *Principia* into French, and the translation and insightful commentary probably helped advance science in France. Nonetheless, Émilie du Châtelet herself was largely forgotten by history (or remembered mainly as Voltaire's mistress) and only recently have her scientific achievements been brought to light.

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Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: Science Research Budgets

By October 3, 2008 when the House of Representatives adjourned, Congress had passed only three appropriations bills: Defense, Homeland Security, and Military Construction-Veterans Administration. Funding for all other FY 2009 activities of the federal government fell under a Continuing Resolution that keeps budgets fixed at their FY 2008 levels until March 6, 2009. At the time of the filing deadline for *APS News*, it remained unclear whether Congress would revisit FY 2009 spending before that date and what alterations it might make before the CR expires or what actions it might take subsequent to March 6.

The increasing likelihood of one or more stimulus packages to address the deepening economic recession could also affect the final disposition of the FY 2009 appropriations legislation. Although the scope and timing of any stimulus action are far from certain, congressional leaders have signaled that infrastructure and "green jobs" are on the priority list. Funding for science programs that have an immediate impact on job creation or job stabilization might make the cut, but until the parameters of the stimulus bills are better defined, the possibility remains speculative.

ISSUE: POPA Activities

At the October 3rd, 2008 meeting of POPA, two draft statements were approved for presentation to the Executive Board: the APS Statement on the Civic Engagement of Scientists and the Joint Diversity Statement.

The first statement deals with the Society's stance on increasing representation of scientists and engineers in public office at the federal, state and local levels, and in positions of responsibility at the federal agencies, to ensure that informed policy and science funding decisions are made. It is the Panel's hope that APS as a whole will strongly support the decision of members of the scientific and engineering communities to pursue such positions.

The Diversity Statement's goal is to effect change that will make physics more inclusive to under-represented minorities and foster greater diversity in physics, at all levels. The organizations jointly proposing this statement include the American Association of Physics Teachers, the American Physical Society, the National Society of Black Physicists, and the National Society of Hispanic Physicists.

Two proposed studies were also reviewed at the October 3rd meeting. The first, which was approved by POPA, will study non-biological CO_2 capture directly from the atmosphere and from post-combustion flue gas exiting a coal or natural gas power plant. The second report, which will be reviewed by the POPA Energy & Environment subcommittee and presented in full form at the February 6th, 2009 Panel meeting, focuses on modernizing the current US energy grid to enable significant expansion of renewable energy. POPA agreed that this was an issue worth investigating, and a vote on the study's progression will be held in early '09.

ISSUE: Washington Office Media Update

The APS Energy Efficiency report has been covered in newspapers, magazines, online news sites and blogs, including *Science*, *Politico*, *St. Louis Post-Dispatch*, *Miami Herald*, *Sacramento Bee*, *Seattle Times*, *Patriot-News* (Harrisburg, Pa.) *The Daily Sentinel* (Grand Junction, Colo.) *BusinessWeek.com*, *Voice of America.com*, *Grist.com*, *CoStar.com*, Energy & Environment TV and Clean Skies TV. The report was also featured in news stories on about 150 radio stations across the country reaching 15.2 million households.

Log on to the APS Public Affairs website (http://www.aps.org/public_affairs) for more information.

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Eastern scientists to avail themselves of training opportunities," said APS Director of International Affairs Amy Flatten, who attended the November inauguration ceremony. "While many can find local support at host training institutions, or food and lodging for the "SESAME Users Meetings," they oftentimes cannot find funds to cover the travel/airfare."

Consequently, the American Physical Society, the European Physical Society (EPS), and the U.K. Institute of Physics (IoP) have agreed to establish a joint SESAME Travel Award Program. EPS, IoP and APS will each provide $5K each annually ($15K jointly) for the next 3 years, for "travel awards" that would enable Middle East scientists to attend SESAME "Users Meetings" or other training opportunities. Flatten is approaching other physical societies to contribute as well.

Herman Winnick, a long-time APS member who currently serves on the APS Committee on International Scientific Affairs (CISA), was one of those who originally proposed SESAME and has been instrumental in promoting it.

SESAME will be a powerful synchrotron radiation source producing light from infrared to x-rays. The synchrotron is built from components of the retired BESSY I accelerator, donated by Germany. SESAME users will conduct research in a variety of areas of research, including physics, materials science, molecular biology, nanotechnology, archaeology, environmental studies, and medical research.

The international physics community has shown its support for SESAME through a resolution recently passed by IUPAP, the International Union for Pure and Applied Physics.

In November, Herwig Schopper ended his term as SESAME council president and Chris Llewellyn-Smith took over the position.

So far, SESAME members are: Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestinian Authority, and Turkey. Other countries in the region could also potentially join SESAME. The United States is an observer, as are France, Greece, Germany, Italy, Japan, Kuwait, Portugal, Russian Federation, Sweden, and the United Kingdom.

SESAPS Presents Awards at Fall Meeting

Photo by David G. Haase

The Southeastern Section of the APS (SESAPS) held its 75th meeting in Raleigh, NC from October 29 to November 1, jointly with the NC Section of the American Association of Physics Teachers, and with Zone 5 of the Society of Physics Students. The meeting was hosted by the Department of Physics at North Carolina State University, and, with 314 registrants, was one of the best attended meetings in the history of the Section. SESAPS has for many years presented annual awards for education, research and service to physics in the Southeast. At left is a photo of the 2008 award winners. Left to right: Michael Fowler (University of Virginia), the George B. Pegram Award for Excellence in the Teaching of Physics; Herbert A. Mook (Oak Ridge National Laboratory), the Jesse W. Beams Award for Research; Lawrence Cain (Davidson College), the Francis G. Slack Award for Excellence in Service to Physics in the Southeast.

Obama Energy Policy on View at Forum

An advance look at Obama administration energy policies was provided at a forum held in October at Stanford University, sponsored by Scientists and Engineers for America in partnership with APS and several other scientific societies. Advisors to both the Obama and McCain campaigns participated in the forum and answered questions from the audience.

There was broad agreement on the urgent need for a range of policies and new technology solutions to tackle the nation's energy problem, though the candidate's platforms differed in the details.

Daniel M. Kammen, Senior Advisor on Energy & Environmental Policy for Barack Obama, and Kurt E. Yeager, co-chair of the McCain California Energy Security Coalition, participated in the debate. Kammen, a professor at UC Berkeley, was also a member of the APS study group that issued a report on energy efficiency in September (see the October *APS News*).

Both candidates recognized the need to implement a variety of measures to solve the energy problem. "This is a critical juncture. Both sides of the aisle, Republicans and Democrats, have awoken to the need to do something about an energy system that is fundamentally out of date," Kammen said.

Obama's energy plan includes developing new renewable energy sources, increased research and development, and a cap and trade system for carbon dioxide emissions.

At the October forum, Kammen emphasized the need to work on both increasing the market demand for clean energy and on increasing investment in developing innovative technology. "You cannot emphasize one part of the equation without the other," Kammen said. "The Obama platform is deep with details on both the technology push, the R&D side, and the market transformation side of the equation."

Obama is committed to a ten-year, $150 billion program divided between dramatically increasing the federal R&D program and building markets for clean energy.

This country invests less in energy research and development than it did before the OPEC crisis, Kammen pointed out. Right now the private sector in energy invests less than half of one percent back into

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INTERNATIONAL News

...from the APS Office of International Affairs

The Physical Society of Visayas and Mindanao, Philippines

By Lolita A. Daral-Ungui

Since many APS members are interested in international development, I want to introduce the American Physical Society to an organization in the Philippines that is promoting physics education and research among increasingly diverse Filipinos with significantly different cultural perspectives, experiences and expectations. Aligning with the APS mission *"to advance and diffuse the knowledge of physics,"* this young organization also aims to collaborate and cooperate with local and international physical societies to promote physics for the benefit of humanity.

The Physical Society of Visayas and Mindanao of the Philippines, locally known as Samahang Pisikang Visayas at Mindanao (SPVM), is an organization of physics teachers, researchers and other physics enthusiasts. SPVM was officially instituted on April 21, 1995 during the National Science Conference on Theoretical and Experimental Physics held at the Mindanao State University-Iligan Institute of Technology (MSU-IIT), Iligan City with Angelina M. Bacala, PhD as Founding President. SPVM has charter members all based in Visayas and Mindanao, Southern Philippines. To date, membership in the organization has expanded to include physics professionals from all regions of the Philippines and a number from Japan and the USA. Presently, SPVM is headed by Jinky B. Bornales, PhD as President and Hitoshi Miyata of Japan as Adviser for International Affairs. Today, SPVM has become a very active professional organization which envisions a scientific community bound by a common desire to advance physics in all fields and to make physics education and research a potent tool for development in the Philippines.

Since its founding in 1995, the SPVM has organized national physics conferences and workshops hosted by big universities in different parts of the Philippines. SPVM-organized national conferences and workshops advance its mission to provide a dynamic medium whereby members can exchange ideas and experiences and be updated on the current state of physics research and education in the Philippines and abroad. Development and publication of teaching materials in general physics; physics enrichment programs among high school students; and holding "Mini-Science Olympics" among underprivileged children during the holiday season are some of the other activities conducted by the SPVM–all aiming at its aforementioned vision.

The 10th SPVM National Physics Conference & Workshop was conducted at the St. Louis University, Baguio City on October 16–18, 2008 with 300 in attendance. Ninety-two scientific papers (7 plenary, 62 subplenary and 23 poster papers) were presented in the conference by physics researchers and educators, high school and college teachers, as well as, graduate and undergraduate

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Letters

Setting the Record Straight on 1987A

The article concerning Astrowatch and LIGO in the August-September issue of *APS News* invites two comments: 1. The supernova was 1987A (1987a was Comet Levy) in accordance with an IAU resolution from long before and custom established by Fritz Zwicky. If there are more than 26 in a year, they become 2008AA, 2008AB, etc.; 2. At the time of the first neutrino alert, there were three bar antennas in operation, two at the University of Maryland, and one in Rome.

The Rome one had gone off the air by the time of the later, second (Kamioka, IMB, etc) neutrino event, but the Maryland ones continued to operate. Data from all three were analyzed and published at the time.

Virginia Trimble
Irvine CA

Ed. Note: *The author is past chair, IAU Supernova Working Group, and widow of Joseph Weber, who designed, built, and operated the Maryland bar antennas.*

Setting the Record Straight on Videogames

The column "This Month in Physics History" in the October *APS News* purports to describe the significance of William Higinbotham's electronic game "Tennis for Two." This demonstration game of a simple physics process, while creative and fun to play, was not the first game played on an oscilloscope. It had no more impact on the future creation of videogames than similar demonstrations made by many engineers and technicians to entertain themselves during idle moments, just as did Higinbotham for that open-house occasion in 1958.

The actual creation of the first videogame took place in September of 1966 when I disclosed the concept and built the first of a series of devices that allowed playing games using an ordinary home TV set. That started the console game industry. Numerous patents issued within a few years covered the interaction of manually and machine controlled symbology on the screen of a TV set or monitor, none of which features were embodied in the Higinbotham demonstration.

These patents were exclusively licensed to the Magnavox company. When license negotiations between Magnavox and Nintendo broke down, Nintendo sued the inventors and their lawyers. The trial took place in New York Federal District Court in front of Judge Sands. Higinbotham was called as a witness for Nintendo, which had refused to come under license of the Baer/Harrison/Rusch patents. The lawsuit was unsuccessful and was adjudicated in favor of Baer et al. Thereafter, Nintendo came back to the table and took a license. Had it not been for Higinbotham's appearances at those court proceedings, the existence of his game would have remained as unheralded as that of other engineers' similar electronics experiments. This in no way negates the creativity of the Higinbotham design or that of others, especially the many more or less successful attempts to play games on refrigerator-sized computers of that era. However, none of these resulted in any way in the concept of, and the creation of the home videogame console industry. They DID, however, experience a rebirth in the creation of the arcade videogame industry by Nolan Bushnell of Atari in the late seventies.

Higinbotham's legacy does not depend on the creation of a game that produced no consequences during a professional life otherwise full of accomplishments, a game that would never have been given prominence according to Higinbotham's own contention during his appearance on the stand, if it hadn't been for a couple of hot-shot lawyers who saw an opportunity to confuse a Federal Judge.

Ralph H. Baer
Manchester, NH

Ed. Note: *Ralph Baer is a National Medal of Technology Laureate. More information about his role in the early history of video games can be found on his website at* www.ralphbaer.com .

CLARIFICATION

A revised version of an article about the APS/AAAS/CSIS nuclear policy report, which was published in the November edition of *APS News*, is now available on the APS web site. The updated article reflects the final version of the report, *Nuclear Weapons in 21st Century U.S. National Security*.

Meeting Briefs

• The APS Southeastern Section held its annual fall meeting October 30–November 1 at North Carolina State University in Raleigh, NC. The technical program covered a broad range of topics, including granular physics, astrophysics, biophysics, atmospheric and geophysics, optics, and particle physics. There were also sessions on the history and philosophy of physics, successful programs in physics education, and a physics demonstration show on Thursday evening.

• The APS New York State Section held its annual fall meeting November 14-15 at the Corning Museum of Glass in Corning, NY, organized around the theme, "A Century of Optics and Materials." In addition to the invited technical talks, the meeting included a tour of the museum and a visit to the Palomar Observatory. Scott Kardell of the Palomar Observatory was the keynote speaker at Friday evening's banquet.

Journals Aim to Improve Access for the Blind

APS journals are developing ways to improve the journals' accessibility to blind people and others with print disabilities while adding enriched content for all users.

Bob Kelly, APS Director of Journal Information Services, is working on converting APS journal articles to a universally accessible format that would give added information to the screen readers that disabled people use to read the content. This could make it possible, for example, for blind people to print graphics in tactile form.

Journals have been structured and typeset to be read on paper, not to be listened to. Most online content has sophisticated tagging and metadata to enhance the content and make it navigable, but most images and graphs lack metadata and aren't searchable. The APS journals currently use XML/MathML formatting for text and equations with figures in Postscript. Kelly is now working on making equations and images in a universally accessible format.

Kelly teamed up with John Gardner, a blind physicist at Oregon State and founder of ViewPlus technologies, which makes products such as Braille printers for people with print disabilities.

By using a new enhanced format for figures, a graph that otherwise is completely inaccessible to a blind user could be made accessible. For instance, a sight-impaired user could feel the slopes of lines on the graph, from an embossed printer, and listen to the software read out values of data points. Graphics with this added information would also be easier to work with, edit, and integrate with text. Sighted physicists might also find the technology useful. For example, a computer could read aloud the information contained in a graph while the scientist looks at something else, such as an experimental instrument.

Switching to universally acces-

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zero gravity

The Lighter Side of Science

Santa Claus is a Physicist

Santa is at least several hundred years old, and you've got to assume that somewhere along the line, he spent some time in academia and probably got a degree or two. Assuming he is a man of science, what kind of scientist might he be?

Now, you might think that there are lots of ways to go with this. You could note the flying reindeer, and say that they're clearly the product of either genetic engineering or at the very least a sophisticated understanding of evolutionary biology. You could take the fact that he manages to deliver toys all over the world as clear evidence that he has found the solution to the Traveling Salesman Problem, and thus is either a mathematician or a computer scientist. But really, all the evidence points to Santa being a physicist.

I mean, it's the only explanation that covers everything. Flying reindeer? Obviously, the product of sophisticated anti-gravity technology. Planning the route? Done with a quantum computer. Likewise, sorting the naughty from the nice, which is clearly some sort of Grover's algorithm issue.

And anybody who can deliver that many toys to that many places in that little time obviously has a deep understanding of relativity and is using a system of wormholes to travel back and forth in time, spreading the toy-delivering out over an entire year of his own subjective time, while the rest of us only see one night.

That's a much more reasonable explanation than elves making toys in a secret factory at the North Pole and towing them around with reindeer. After all, the supply chain issues alone would be a nightmare, and the speed and weight issues are well known. Spread that load out over an entire year, though, and it becomes much more reasonable, particularly if the wormholes can be targeted to individual houses.

This also explains the chimney thing–he doesn't actually enter via the chimney, itself (which would be impractical for a fat man with a bag of gifts), but rather through a wormhole whose mouth is located in the vicinity of the fireplace, which is obviously one of the safer places in the average house to do that sort of thing, as you can be sure that there won't be anybody standing there when the wormhole opens.

So, clearly, Santa Claus is a physicist. It's the only explanation that makes sense.

Chad Orzel is a physics professor at Union College, and also blogs at Uncertain Principles.

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was really eye-opening", said senior Emmaris Soto of the University of Connecticut.

Speaker Philip Hammer, Vice President of the Franklin Center, stressed that civic scientists must understand the nature of political discourse and the boundaries of scientific authority. "Progress comes through compromise and consensus," he said.

Exhibitors representing graduate school programs and scientific societies and organizations filled the halls as students mingled with fellow members and physicists. "It's very gratifying to see everything come together. What I really like is the conversation–everywhere you turn, every table or exhibit you walk by is just vibrating," said Gary White, Director of the Society of Physics Students.

"The Congress is great for meeting influential people in the community and making contacts. There is so much other research going on, but it's easy to get bogged down and narrowly focused on your own lab. The Congress provides a way to become aware of all the other research that's out there," said senior Kileigh Peturis of The University of Southern Mississippi.

Search for Extraterrestrial Intelligence (SETI) researcher Jill Tarter kicked off the plenary lecture series by posing some profound cosmic questions. "Can planets orbit stars like pulsars? Can two technological civilizations detect each other? We don't know the answers…yet," said Tarter.

"I really liked Dr. Tarter's lecture. I previously did an independent study in cosmology and astrophysics, so I felt right at home," said senior Chaan Thomas of Chicago State University.

Attendees also had a chance to foster dialogue on perhaps the most challenging social issue in physics–race and gender diversity in the workforce. The representation of women and under-represented minorities in physics has changed over the last several years. These "future faces of physics" will most likely be women, according to Rachel Ivie, Assistant Director of the Statistical Research Center at the American Institute of Physics (AIP). While the representation of women among physics bachelor's and PhDs has been steadily increasing, it remains the lowest among all other sciences. On the other hand, the percentage of African Americans and Hispanics who hold physics degrees is "extremely low and has changed little since 1994," Ivie stated.

Collectively signing a letter promising to speak out against racism as civic scientists, participants vowed to uphold the pledge of Einstein, whose active work against racism remains largely unknown, at a lecture by Fred Jones and Roger Taylor, co-authors of *Einstein on Race and Racism* revealed.

A Congress highlight was the closing plenary lecture "What Presidents and Physicists Need to Know about Science" by Leon Lederman, 1988 physics Nobel Laureate and Director Emeritus of Fermilab. With visible optimism and humor, Lederman implored young physicists to use their scientific skills to help solve the many challenges our nation and planet face, while emphasizing the impact that public science literacy and education will have on developing future solutions to these problems.

"The Obama credo of change matches the scientific tradition; change is also what science is about, it is what science produces," said Lederman.

For many attendees, holding the Congress at Fermilab has a special significance. "Fermilab is such a big part of physics. Even though I'm not planning to work in the particle physics field, I really wanted to see it," said senior Devin Underwood of the University Wisconsin-River Falls.

The Laboratory's rich history of scientific discovery made tours of the main building and 6,800 acre premise memorable. "Students were actually up early waiting for the 7:00 a.m. buses to Fermilab–college students!" exclaimed Kendra Rand, program coordinator for the Society of Physics Students.

A physics star among the stars

By Alaina G. Levine

Tammy Jernigan was in space when she faced a curious conundrum concerning a floating ball of fluid. As an astronaut, she had been charged with many tasks of a scientific and engineering nature, as well as the opportunity to produce educational and outreach materials to inspire kids to study science. When it came time for her and her crew to create a video in which they performed a specific creative space-based demo, they found themselves facing an unforeseen challenge: how do you still look professional assembling and then drinking from a sphere of liquid while floating in space?

Jernigan, former astronaut, physicist, and now the Associate Director for Strategic Human Capital Management at Lawrence Livermore National Laboratory (LLNL), recalls performing this demo as one of the funniest moments of her otherworldly experience, as well as one that actually helped her launch a career in human resources (HR).

She and her astro-colleagues were filming what was supposed to be a cute educational video in which they took a drink bag with a straw, squirted the liquid into a free-floating ball, and then poked straws into the liquid to drink it out of the air. The final video "makes it look pretty straightforward and neat," Jernigan, 49, recalls. But it took many takes. "We made a hideous mess."

She learned a few vital things from this experience. First, while Earth-based spills generally contain the mess within one location, in space, "if you bump a sphere of liquid, it goes into hundreds of little droplets that spread out in three dimensions all over the place." Second and consequently, "gravity is very convenient." And third, and most importantly, it's the people with whom you work that make all the difference in the success of any mission, both earthbound and beyond.

Jernigan understands this from many different levels, because at LLNL she is in charge of all HR activity, which she categorizes as "strategic forward-looking, proactive workforce management." She must be a visionary and a realistic planner in terms of resources, both human and monetary, and anything else that can influence how LLNL reaches its goals.

Prior to this she served as Principal Deputy Associate Director of Physics and Advanced Technologies. Her deep understanding of the operation and science side of the lab propelled her towards the HR position and ultimately landed her the job of taking "workforce management to a new level at the laboratory," she says.

This year, the lab underwent its first layoffs in over 30 years. "We had a contract transition," she explains, "and the intersection of the increased cost of doing business associated with the contract transition, inflation and a large lab budget reduction caused the layoffs. …You're making some projections about what the research portfolio and mission portfolio are going to be in the future."

The fact that she studied physics and had served on the technical side of the lab for six years before rotating into HR aided her tremendously in dealing with this challenging situation.

She considers her scientific background essential in having an appreciation of the needs of the lab from many different angles. "My physics background and my relationships with the physics and mission directorates (of the lab) really help me to understand the mission of the laboratory and the challenges of executing a national security mission and doing fundamental research in support of that mission," Jernigan notes. This diverse experience helps her to identify and ask (and answer) the right questions to ensure the success of the lab now and in the future.

Asking and finding answers to problems was actually what got her interested in physics and math in the first place. As a child, "I always liked the beauty and elegance of math," she says. "I liked the fact that there was always an answer. In science it was so interesting to me to figure out how the world worked and why things behaved the way they did."

With a bachelors in physics and a masters in engineering, both from Stanford University, she laid out a career course for herself that leaned toward academia for a few years, with the hope of becoming an astronaut someday. However, while working on her PhD on interstellar shockwaves at the University of California at Berkeley, she herself experienced a career shockwave when she was selected for the astronaut program. She was only 26 years old. She moved to Houston to train and finished her doctorate at Rice University.

Jernigan has logged 1,512 hours in space during her five missions, including a number of space walks. She says the ride into space is especially thrilling as you are "sitting on eight million pounds of thrust as you accelerate to 18,000 miles per hour."

"Once you get there it is an incredible feeling of freedom to float effortlessly through the spacecraft or to do a spacewalk and see this extraordinary planet that we inhabit from the vantage point of space," she describes.

And while she didn't consider herself an environmentalist before she became an astronaut, she was moved by her experience in space to have a greater appreciation for our natural resources.

"You look at the planet and there are no borders and dividers," she says, half joking that this has helped her be better at her HR job since she has to do international recruiting.

But in all seriousness, "I had a very compelling sense that we're all in this together," she says. "You see the fragile atmosphere and this lone blue orb suspended in the darkness and you think we have been entrusted with this beautiful Earth and we really have to be good stewards of our planet."

As a physicist and an astronaut, Jernigan has developed skills that have helped her succeed in all of her careers. From an understanding of what's required to do basic science, to an appreciation of the importance of teaming and working well with people, Jernigan realizes that having studied physics, she is better prepared for whatever comes her way.

"In physics you learn a certain approach to a problem, that I think you can apply in many areas of your life," she says. "It's a general view of the world of trying to be a problem-solver and sit at the table with other problem-solvers and work together to try to come up with the best solution possible."

She sees parallels between the skills she uses as a HR manager and those she used as an astronaut and a physicist.

"It's all just having an intellectual curiosity. Wanting to understand [the issues].... All these things are about problem-solving, whether you are in a laboratory, working with a computational physics problem, or a workforce restructuring problem," she explains. "[One asks] what is my optimum solution? How do I bring in the best ideas? How do I integrate those ideas?"

In HR she has enjoyed learning about professional development opportunities for employees and has mentored many people, especially those early in their vocations. Regarding their careers, she advises her protégés to "choose something that they really love and that they're going to be passionate about because that's where they're going to do their best work."

And she encourages physicists in particular who want to be leaders in their fields, be it in a lab in space, an office on Earth, or something in between, to add breadth to their backgrounds and concentrate on teambuilding. Learn to lead a team well and to follow well, she says. And of course, it also never hurts to learn the science (and art) of fluid dynamics in zero-gravity environments.

DNP Holds 2008 Annual Meeting in Oakland, California

The APS Division of Nuclear Physics (DNP) held its 2008 annual meeting 19-23 October in Oakland, California. The technical program featured talks on the latest in neutrino physics, the status of a new project to probe the nature of dark matter/dark energy, and the role nuclear physics is now playing in planned space missions and hadron radiotherapy, among other research topics. In addition, three half-day topical workshops were held the day before the meeting on quantifying the character of the quark gluon plasma; large-scale computation in nuclear physics; and underground nuclear physics experiments.

Cracking the Neutrino Code. For a particle with no charge and very little mass, neutrinos are appear to be very complicated in terms of their properties, according to R.G. Hamish Robertson of the University of Washington. For instance, it took 70 years after their discovery before scientists realized they had a tiny amount of mass, although the exact value of that mass remains unknown.

Melissa Jenkins (University of Texas at Austin) believes that recent advances in atomic slowing and cooling are opening up new avenues for exploring neutrino properties, such as mass. Neutrino physicists have long used tritium beta decay to probe the "ghost particle," but thus far have failed to detect the mass. Jenkins proposes to improve matters by using a slow, cold beam of tritium atoms as a neutrino source.

Although the central focus of current neutrino experiments not involving accelerators is the study of their properties, other researchers are harking back to the past and using neutrinos as probes to investigate the processes by which they are produced by the sun. According to University of California, Berkeley's Michal Patrick Decowski, some of these new experiments will also measure anti-neutrinos from the decay of uranium and thorium in Earth's crust and mantle, thereby possibly providing information on the radiogenic contribution to the planet's heat balance. Other experiments will utilize neutrinos produced in reactors for nuclear non-proliferation purposes.

Probing the Dark Side of the Cosmos. Tony Tyson of University of California, Davis, gave an overview of the status of the Large Synoptic Survey Telescope (LSST), which is slated to begin analyzing a wide range of cosmological phenomena in 2014. For instance, according to Tyson, the nature of dark matter can be constrained by measuring the scales on which it clumps, while the nature of dark energy can be constrained by measuring the time evolution of cosmic dark matter structures, as well as measuring the distribution of galaxies and the cosmic "shear" of their apparent shapes. The LSST will also make it possible to compile maps of dark matter and carry out several independent cross-checking probes into the nature of dark energy.

Nuclear Physics and Human Biology. Ram Tripathi of NASA's Langley Research Center reviewed the vital role nuclear physics is now playing in such diverse areas as planned space missions, hadron radiotherapy, and low-dose radiobiology. For instance, NASA's future vision for space exploration includes missions to the moon, Mars, and beyond, with a corresponding focus on long-duration space missions, and thus, protecting astronauts from long-term exposure to space radiation. Furthermore, advances in human genome sequencing and new radiobiological techniques have made it possible to determine at the cellular level how living systems respond to low doses of radiation. And proton radiotherapy is becoming more common as a cancer treatment.

Computational Modeling of Supernovae. Adam Burrows of Princeton University discussed recent progress on simulating a supernova explosion in six-dimensional phase space (plus a seventh dimension of time), which he expects to improve even more over the next five years. In particular, he probed the theoretical mechanism of supernova core collapse via a series of massive computations, which he believes will shed

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What Answer Did You Get?

Photo by Ken Cole

Nathanael Smith of Middle Tennessee State University, and Ming Tian of George Mason University collaborate during a breakout session at the New Physics and Astronomy Faculty Workshop, held at the American Center for Physics in College Park, MD in early November. The workshop provides new faculty with the latest information on how students learn physics and astronomy, and gives them practical suggestions on how to improve their teaching methods. This annual event, which began 12 years ago, has been steadily increasing in popularity. Ninety-five new faculty members attended in 2008. The conference is funded by NSF and sponsored by the American Association of Physics Teachers, the American Astronomical Society, and the APS.

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R&D.

Obama supports a cap and trade system for carbon dioxide emissions, with permits to be auctioned, not given away. Obama also proposes using funds generated through the cap and trade system to fund energy initiatives for inner cities. "We can't make energy a have and have not issue," Kammen said. In addition, green technology "is one of the areas of true job creation." Kammen said.

Another key part of the discussion is the role of energy efficiency, Kammen said. California, New York, and several other states are forty percent more efficient than the national average. The rest of the country can learn from those states, Kammen said. Energy efficiency must be made much more business as usual everywhere, not just in a few states, he said.

Unlike McCain, Obama supports windfall profits tax on oil, said Kammen, pointing out that there are good economic indicators that oil companies have reaped a windfall profit, and that they have under-invested in research.

Obama has also been supportive of a long-term extension of the investment tax credit. "This is one of the most effective mechanisms we have developed in this country" to support the growth of clean technology, said Kammen.

While McCain's energy plan stressed building new nuclear power plants and developing clean coal technology, Obama's plan focuses on developing a variety of renewable energy sources. Kammen called McCain's vision of 45 new nuclear plants unrealistic, though Obama supports nuclear power if it can be done safely. Obama opposes Yucca Mountain as a storage site for nuclear waste, but believes that nuclear waste can continue to be stored at power plant sites until a better permanent solution is agreed upon.

Obama also supports a mandated federal portfolio standard for renewable energy as well as investments in modernizing the grid.

Recognizing the need for energy independence, Obama would support some offshore drilling for oil if it is part of a broader compromise that brings about investment in clean energy alternatives, Kammen said, but he would not force offshore drilling on states that do not want it.

Since about 50% of electricity in the US comes from coal, and coal will probably continue to be a major source of energy for many years to come, Obama supports developing clean coal technology, even though that technology is probably a decade away.

Obama also wants to push companies to make more efficient products and empower consumers with more information than just the Energy Star rating. "We have not pushed anywhere near hard enough on electronics companies," Kammen said.

International efforts are also needed as China and other countries are likely to significantly increase their energy use. "The United States has been a spectator to an evolving international effort for far too long. Obama is committed to getting the US to reengage substantively on this issue," Kammen said.

Obama made energy one of the most important issues of his campaign, said Kammen. "We are going to have to make clean energy job one."

Fluid Dynamicists Hear About Oil Spills, Wind on Jupiter, and More

The physics of oil spills, how germs spread in airplanes, and the best velocity maps to date of wind speeds on the planet Jupiter were among the highlights of the 61st Annual Meeting of the American Physical Society (APS) Division of Fluid Dynamics, held November 23-25 in San Antonio, Texas. More than 1,500 papers were presented on the latest research in fluid dynamics, with applications ranging from astronomy and engineering to alternative energy and medicine.

Jupiter's Shrinking Red Spot! The best map of wind speeds on Jupiter ever produced proves that the massive weather system known as the Great Red Spot has shrunken over the past dozen years. Understanding cloud patterns on distant planetary surfaces, such as those at Saturn or Jupiter, is potentially confusing because clouds deform over time. Using sophisticated software, scientists at the University of California at Berkeley have been able to take the deformations into account (and the much easier-to-deal-with factor of the planet's rotation) and have calculated the best velocity maps yet for the surface of Jupiter.

Using data recorded by the Galileo and Cassini spacecraft, views of Jupiter's surface have been made that essentially factor out the planet's rotation, simplifying the view of what is happening to the cloud decks. For mid-latitudes, the velocity resolution for this mapping procedure is 3 m/s. For higher latitudes, the resolution is 3 m/s to 6 m/s. The maps consist of tens of millions of velocity measurements.

According to Berkeley scientist Xylar Asay-Davis, these maps represent the highest resolution and highest accuracy full-planet map ever produced. With this approach, such meteorological features as the Great Red Spot or the Red Oval can be monitored more carefully than before. The high-precision velocity measurements show definitively that the Great Red Spot has shrunk over the past dozen years, says Asay-Davis.

Spill, Baby, Spill. Oil spills are a major environmental problem because they often occur at sea and in remote, ecologically-sensitive areas where their impact on birds, sea mammals and subsurface life may last for years. The best way to mitigate this damage is to clean up spills immediately, and typically this starts with skimming off as much oil as possible. Such cleanups may leave large areas covered with a thin slick of spilled oil, which is often dispersed by spraying the spill area with chemical "surfactants" that break the film into small oil droplets that are consumed by bacteria, dissolved, evaporated, or attached to small solid particles and sink to the bottom of the ocean.

When dispersants are sprayed over a spill in the open sea, the turbulent mixing forced by ocean currents and the wind actually helps in the cleanup process, but how much such turbulence contributes is not completely understood scientifically. Up to now, the breakup of oil mixed with dispersants has not been thoroughly studied in the laboratory, and there is little information on how wind, weather, and other local conditions contribute to the effectiveness of a cleanup process.

Now Johns Hopkins graduate student Balaji Gopalan and his mentor Professor Joseph Katz have imaged the dispersion of tens of thousands of oil droplets in carefully controlled laboratory settings and observed the effect of local turbulence on this process. Pre-mixing the oil with the commercial dispersant COREXIT 9527, they observed how it breaks into numerous tiny droplets smaller than the period at the end of this sentence. Following each droplet in three dimensions, they observed how tails or thread-like structures grew from its surface, the thickness of the tails being less than 17 micron in size, and the breakup of which could produce even smaller droplets.

This better understanding of the basic physics of the dispersion process should allow environmental engineers to better predict how well dispersants will work in the field, says Gopalan, which should help inform decision makers during major oil spills. The work is part of a large collaboration among biologists, ecologists, physical oceanographers, computer modelers, and engineers, primarily associated with the Coastal Response Research Center, that aims to model and predict the fate of oil after it spills, taking into account the properties of the oil, dispersant, weather conditions, and ecological data. In the future, an improved "response model" based on this larger collaboration may suggest the optimal approach to cleaning up any specific oil spill.

Trapping Greenhouse Gases. Of all the possible ways of reducing future greenhouse gas emissions, one of the most immediately feasible is carbon dioxide "sequestration," which involves compressing the gas into a liquid and piping it deep underground instead of releasing it into the atmosphere. Earth has abundant geological formations known as saline aquifers that would seem to be ideal storage bins for such sequestered carbon.

However, says Jerome Neufeld of the University of Cambridge in England, if carbon sequestration is to play a major role in reducing greenhouse gas emissions, the process needs to be deployed on a global scale, and new tools will be needed to monitor the long-term stability and fate of trapped gas.

The principle of sequestration is simple. Saline aquifers are basically porous regions of rock soaked with brackish fluids. The density of carbon dioxide is much less than that of the brine, so gas pumped into the aquifer will rise through the porous rock until it hits an impermeable "cap" rock. Over very long time scales, trapped carbon dioxide will saturate the brine and become mineralized. But what happens in the short term? If you pump carbon dioxide into saline aquifers, will it stay put and mineralize or leak away completely?

Neufeld and his colleagues have created a simple tool to predict the fate of carbon dioxide "plumes" rising though aquifers after being pumped underground. Their model shows how the shape of rising plumes is influenced by the structure of the surrounding rock, and it suggests that there are advantages to injecting carbon dioxide into reservoirs that are like geological layer cakes, with alternating stacks of porous and seal rock. When a plume reaches an impermeable boundary, it spreads until it can rise again, filling out a shape that looks like an inverted Christmas tree. As the plume pools it mixes with the brine, ultimately resulting in a more stable long-term sequestration.

Those Flexible, Flappable Flying Machines. Modern aircraft have been fabulously successful with rigid wings and rotors. But just imagine the flying machines that would be possible if we could understand and harness the most efficient and acrobatic airfoils in nature: the flexible wings of the bat.

The aerodynamics of "compliant" structures, such as bat wings, are very complicated because both the structure and airflow change and adapt to each other in a highly nonlinear way. Bats' wing bones are even flexible, unlike those of birds, which gives the mammals added control but is an additional challenge for scientists trying to understand them. Kenny Breuer's research group at Brown University is designing a series of fundamental experiments that will allow scientists to isolate, observe and analyze a variety of specific flow-structure interactions that are important in understanding bat flight and, in general, the aerodynamics of compliant structures. Ultimately, Breuer expects that experiments like these will yield insights enabling new generations of flying machines that are impossible to consider today.

Arnold Song, who is one member of this research group, described the basic motions–and their aerodynamic implications–that he and his colleagues at Brown have discovered so far by measuring how paddles and stretched ribbons of sailcloth vibrate in manmade breezes in a wind tunnel. As the airflow increases, for example, a paddle on a post first twists and then flaps, like a stop sign being pummeled by hurricane-force winds. The ribbon's behavior is more complicated, but also essential for understanding how bat wings or other compliant structures generate lift so efficiently.

How Germs Spread in Airplanes. Airliner ventilation systems are designed to limit passengers' exposure to airborne particles–from ill travelers' contagious germs to terrorists' aerosol biohazards. Vents in a plane's center ceiling direct air out and down toward the floor below the windows, creating a swirling flow pattern within each row of seats that effectively confines contaminants to a single row or, at worst, its next-row neighbors.

But new research at Purdue University has shown that anyone–a flight attendant or a passenger, for instance–merely walking down an airliner's aisle will disrupt this carefully designed flow pattern by creating a wake of eddies that can spread contaminants as far as 10 rows away. Moreover, lead scientist Michael Plesniak says, the eddies' interaction with the ventilation system's swirling flow creates a stagnant zone "at just the wrong place." The height of the stagnant zone is exactly where seated passengers breathe. Future research aims to devise ways for breaking up this stagnant zone and reducing the ability of wakes from people moving around the cabin to disperse contaminants.

Plesniak described his team's re-

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ANNOUNCEMENTS

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

Colloquium: Andreev reflection and Klein tunneling in graphene

C.W.J. Beenakker

This Colloquium describes the underlying physics of two electronic processes that occur in a carbon monolayer (graphene): the electron-to-hole conversion at an interface with a superconductor (Andreev reflection) and the tunneling through a *p-n* junction (Klein tunneling). Both processes have an analog in relativistic quantum mechanics, and the excitations occurring in each of them are described by a variant of the Dirac equation for massless fermions. Furthermore, the chiral tunneling in normal and superconducting junctions in graphene is discussed from a unified perspective.

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

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 2009 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 two pages, a two-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.

Job Fair

Looking for a job? Looking for the ideal candidate?

Don't miss these opportunities!

APS March Meeting Job Fair

Date: March 16-17, 2009

Place: David L. Lawrence Convention Center, Pittsburgh, PA

Register today at: http://www.aps.org/careers/employment/jobfairs.cfm

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light on the enigma of star death in the cosmos.

Burrows' efforts will likely benefit from plans to expand development of petascale computational systems for nuclear physics research. James Sexton (IBM T.J. Watson Research Center) reported that the first sustained petaflop system has now been delivered to Los Alamos National Laboratory, and described the current status of systems architectures for petascale computing and the present challenges in terms of power, memory capacity, data management, and reliability.

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sible format could also make it easier to add enriched content such as interactive data, figures, and equations that all users could benefit from.

Kelly and Gardner have demonstrated a proof of concept, using files from one of the APS journals to show that APS journals could be published in a universally accessible format (DAISY, Digital Accessible Information System) for very little cost. A DAISY format would make possible improved navigation for sight-impaired people.

They have presented the proof of concept at several scholarly publishing conferences. "It was overwhelmingly positively received in the publishing community," said Kelly.

Next, software and procedures must be developed. Kelly has been working with the typesetting vendors to develop the software and composition protocols needed.

When the new accessible format is implemented, APS journal users will still be able to read APS journal articles online with a standard browser, and sight-impaired people will be able to navigate articles with a DAISY reader.

APS expects to offer one of its journals with this universally accessible option in 2010. Further enhancements will continue to be developed.

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students. The seven plenary papers focused on the conference theme "SPVM@Luzon: Expanding Physics Frontiers for Filipinos."

Dr. Alfonso T. Albano ("Balik Scientist") of Bryn Mawr College, USA talked about *The Quest for Quantitative Measures of Time Dependent Behavior,* while Dr. Hitoshi Miyata of Japan's Niigata University expounded on the standard model of elementary particle physics and beyond. The status of the Philippine government "LPONPEP" (Learning Physics as One Nation-Physics Essentials Project) was presented by Dr. Maria Victoria C. Bernido, the project director. *Modeling Neural Processes: A White Noise Functional Approach* was discussed by Dr. Christopher C. Bernido of the Research Center for Theoretical Physics (RCTP) based in Jagna, Bohol. Significant positive results in physics education among Filipino students using innovative techniques in the physics teaching-learning process were ably presented by Dr. Elizabeth P. Melchor, VPAA, Far Eastern University, Manila and Dr. Joel V. Lubrica of Benguet State University. Success stories of the application of physics principles in bio-medical sciences were discussed by Dr. Paulina A. Bawingan of St. Louis University, Baguio City.

SPVM's vigor to fast-track science literacy, particularly in physics, in the Philippines is sustained by the spirited vigilance of its members and by the continuous support of MSU-Iligan Institute of Technology, the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD) of the Department of Science and Technology (DOST) and by other generous agencies and private individuals who firmly believe in the advocacy of the Samahang Pisikang Visayas at Mindanao (SPVM).

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search and how it is also helping to create a computational turbulence simulation software tool that airplane manufacturers and safety regulators could use to model complex, realistic cabin ventilation scenarios more rapidly and economically than is now possible. The tool could also be used to design ventilation systems for interiors of buildings, subways and tunnels.

Improving Jet Engine Performance. Actions similar to those of a pulsating water-massage shower head may lead to more effective control of rocket engines and cleaner, more efficient jet aircraft engines, UCLA scientists have discovered. Juliett Davitian described new research into the behavior of "transverse" jets, which consist of gas or liquid injected into a crossflow of a similar fluid. Engine manufacturers use transverse jets to introduce gases into jet engines for reducing emissions or cooling the turbine blades. These jets are also used to control the thrust of rocket engines.

In some applications, rapid and thorough mixing of the jet and crossflow fluids is needed. In other cases, deep penetration of the jet into the crossflow is desired. Sometimes both characteristics are required. By studying the fluid-mechanical interactions between transverse jets and the crossflow under a wide range of controlled conditions, the UCLA scientists learned that pulsing the transverse jet fluid in sinusoidal or square-wave patterns, depending on the conditions and desired outcome, can greatly enhance mixing, penetration or both. Continuing research will explore the behavior of transverse jets of different densities, which have a wide range of practical applications in energy-generation devices, such as stationary power plants and utility burners.

Mysterious Sand Ripples on Mars. When the Mars Exploration Rover Opportunity landed on fresh Martian sand ripples in 2004, its onboard microscope showed the grains there to be much finer than predicted, revealing a major mystery to be solved. As on Earth, Mars' famous dust storms loft the finest particles high into the atmosphere, while coarser particles bounce along the surface, forming ripples and dunes. Well-established theories developed for Earth ripples in air and water and extended to Martian surface conditions predicted that the transitional particle diameter between these behaviors on Mars would be four times that of Earth's. Yet they were essentially the same. Why was the established theory wrong for Mars?

Numerical simulations performed by a team at Cornell University now suggest a plausible answer. It turns out that the combination of the Martian atmosphere's low density–100 times less than Earth's–and the higher wind speeds necessary to move grains of any size on Mars conspire to make Martian winds less effective than Earth's in lifting particles high into the air. The simulations showed why: Particles react more slowly to an upward turbulent eddy on Mars (due to low atmospheric density) and the eddies themselves pass by so much faster (due to the high wind speeds) that they don't have the combination of power and time to elevate the larger particles, even in Mars' lower gravity.

David Korda described the team's simulation. He and his colleagues are preparing physical experiments to use in a NASA-Ames wind tunnel that can imitate Martian atmospheric conditions to see if the simulation's prediction is accurate.

The Back Page

Econophysics and the Current Economic Turmoil

By H. Eugene Stanley

Almost every physicist by now has heard of the fast-growing subdiscipline of "econophysics", a field characterized by collaborations between physicists and economists and focused on asking if new insights or even laws could emerge if the concepts and approaches of statistical physics were brought to bear on questions that originate in economics. And almost everyone, physicist or nonphysicist, has by now heard that the economies of every country–large or small, Eastern or Western–are witnessing truly huge fluctuations. So it is natural to ask

"Does econophysics have anything to say about the current financial/economic turmoil?"

The answer to this question is a resounding "Yes!" since econophysics is statistical physics applied to the economy, and fluctuations are the substance of statistical physics. In economics, the probability density function (pdf) of price changes has been studied for over 100 years, ever since the PhD thesis of Bachelier in 1900 analyzed real data–without benefit of computers. Then, to understand the pattern he witnessed, he introduced a model which today we call the drunkard's walk. This is the model immortalized to the general public in the aphorism "random walk down Wall Street."

Approximately 50 years ago, as more data became available, it became clear that the drunkard's walk fails to describe all the data. The term "fat tail" was used to describe the mathematical counterpart of this statement, that the pdf of price changes contains many more events in the tail than predicted by the Gaussian pdf characterizing the drunkard's walk. Nonetheless, more than 99 percent of the then available data were reasonably approximated by a Gaussian, so a terminology grew up where events corresponding to these fat tails became known as "rare events," or sometimes "tsunamis." Since there was no theory for them, some argued, and since they are indeed very rare, we can as well ignore them. The word "outlier" is sometimes used to describe a data point that does not conform to the widely used Gaussian distribution of price fluctuations.

Then along came the physicists, starting about 15 years ago when the neologism "econophysics" was coined by this author to describe efforts to apply physics approaches to this and other questions of interest in economics. This field can trace its roots to Newton and Copernicus, two physicists who worked extensively on economics problems, and to a number of others over the centuries who applied to economics the fundamental approach of physics. First, to be eternally skeptical of everything–especially in this case of the practice of calling something that does not agree with a theory an "outlier" or "tsunami." And, perhaps most importantly, to collect as many data as possible before making any theory to interpret them.

Unlike traditional topics in physics, where collecting data often requires imagination and sometimes years of painstaking labor, in the case of price changes every transaction of every stock is recorded and stored. Apparently all the data were not analyzed, so two Boston University graduate students, Parameswaran Gopikrishnan and Vasiliki Plerou (now happily married!), set about to acquire and analyze the data on every transaction...such a voluminous data set that their University computer system had to acquire a significant addition to its storage capacity.

When they analyzed these data–200 million of them–in exactly the same fashion that Bachelier had analyzed data almost a century earlier, they made a startling discovery. The pdf of price changes was not Gaussian plus outliers, as previously believed. Rather, all the data–including data previously termed outliers–conformed to a single pdf encompassing both everyday fluctuations and "once in a century" fluctuations. Instead of a Gaussian or some correction to a Gaussian, they found a power law pdf with exponent -4, a sufficiently large exponent that the difference from a Gaussian is not huge; however, the probability of a "once in a century" event of, say, 100 standard deviations is exp(-10,000) for the Gaussian, but simply 10^{-8} for an inverse quartic law. If one analyzes a data set containing 200 million data in two years, this means there are only two such events–in two years!

Now which is better, the concept of "everyday fluctuations" which can be modeled with a drunkard's walk, complemented by a few "once in a century" outliers? Or a single empirical law with no outliers but for which a complete theory does not exist despite promising progress by Xavier Gabaix of NYU's Stern School of Management and his collaborators? Here we come to one of the most salient differences between traditional economics and the econophysicists: economists are hesitant to put much stock in laws that have no coherent and complete theory supporting them, while physicists cannot afford this reluctance. There are so many phenomena we do not understand. Indeed, many physics "laws" have proved useful long before any theoretical underpinning was developed . . . Newton's laws and Coulomb's law to name but two.

And all of us are loathe to accept even a well-documented empirical law that seems to go against our own everyday experience. For stock price fluctuations, we all experience calm periods of everyday fluctuations, punctuated by highly volatile periods that seem to cluster. So we would expect the pdf of stock price fluctuations to be bimodal, with a broad maximum centered around, say, 1-3 standard deviations and then a narrow peak centered around, say, 50 standard deviations. And it is easy to show that if we do not have access to "all the data" but instead sample only a small fraction of the 200 million data recently analyzed, then this everyday experience is perfectly correct, since the rare events are indeed rare and we barely recall those that are "large but not that large".

The same is true for earthquakes: our everyday experience teaches us that small quakes are going on all the time but are barely noticeable except by those who work at seismic detection stations. And every so often occurs a "once in a century" truly horrific event, such as the famous San Francisco earthquake. Yet when seismic stations analyze all the data, they find not the bimodal distribution of everyday experience but rather a power law, the Gutenberg-Richter law, describing the number of earthquakes of a given magnitude.

There is another problem with accepting an empirical law that quantifies the probability to experience a financial shock of a given size. Many scientists, especially economists, feel that it is better to really understand a law before proposing it. However imagine what must have happened when earthquake specialists uncovered the Gutenberg-Richter law describing the number of earthquakes of a given magnitude. San Francisco last experienced a truly huge earthquake in 1906. Do we ignore the Gutenberg-Richter law that informs us the precise probability of another San Francisco earthquake of comparable magnitude because we do not understand it? Or do we design San Francisco buildings so that they withstand once-in-a-century earthquakes?

Similarly, do we ignore the inverse quartic law that fits all the data including once-in-a-century events? Or do we design a financial system that has safeguards to minimize the damage when one of these rare events actually occurs?

We cannot predict the future but we all know what already happened. Governments worldwide made no contingency plans, and when the current crisis finally appeared to not "just go away," meetings of experts were called and policies hastily crafted. We cannot know at this stage if these policies are the best possible or not, but the speed with which they were crafted seems incommensurate with the fact that we physicists knew for 10 years the probability of shocks of this magnitude, just as we know the probability of an earthquake of a given magnitude. California buildings are required by government to be reinforced, but financial systems are not. Indeed, the haste with which current policies were adopted clearly has the potential for making a bad situation worse than it would be if more careful policies were proposed, back-tested on real economic data, refined, and discussed at all levels from many points of view, by individuals from the Paul Krugmans to the Alan Greenspans.

I now briefly address a second question, a question raised frequently by the news media: *"There have even been accusations that physicists are to blame for what's been going on, because they have allegedly invented the complex financial instruments that nobody else understands but that are now doing us in."*

It is indeed true that physicists have been among those who invented complex financial instruments. But so what? Physicists also invented many other things that others have used for destructive purposes. Bernoulli invented the principles underlying flight yet it is not customary to blame physicists for flight accidents caused by the failure of these principles (in, e.g., turbulent air conditions). Nor is it customary to blame physicists for the nuclear disaster at Chernobyl despite the acknowledged role that physicists have played since Frisch and Meitner first proposed the idea of nuclear fission. It is natural to want someone to blame for major disasters... whether the disaster is completely natural like Hurricane Katrina or man-made like the current economic crisis. Just as the fundamental flaw that made Hurricane Katrina the disaster it was involved not preparing for the unlikely event of a direct hit of a major storm, so also the fundamental flaw that causes much of today's economic problems is not preparing for the unlikely event of a very large economic fluctuation.

In any case, the probability of a disastrous economic fluctuation seems to be fairly independent of time period, since Plerou and Gopikrishnan found that the same inverse quartic law holds for different time periods in history, dating back as far as the 1929 crash...long before physicists were as popular as they are now on Wall Street. So if it is the physicists who are to blame, how do we explain the fact that large and not-so-large crashes have been appearing with frequencies that are approximately time-independent?

But if one wants a scapegoat then you can look no further than the author of this article. The inverse quartic law is a quantitative, not a qualitative, law: it tells the exact probability of a crash of a given size. So before the inverse quartic law, one knew only the qualitative statement that rare events do occur, but not the exact probability of a rare event, making it easier to ignore since indeed the events are very rare. Why didn't we write letters to those with the power to plan exactly what to do when the "once in a century" bad news indeed occurs?

Physicists do not generally stop at extracting empirical laws from data. Additionally, they try to understand the laws. What can a physicist offer as a first step to begin to understand the fact that there appears to be scale-free phenomena at work in stock price fluctuations? I can offer a tentative picture–based largely on analogy with another scale-free phenomenon, a system near its critical point (now called a "tipping point" due to the popular book of this title by Malcolm Gladwell). Indeed, physicists often like to argue by analogy, on the "parsimony principle" (often credited to Feynman) that there are not that many fundamentally different phenomena.

Large strides were made in understanding the scale-free phenomena occurring in systems near their "tipping points" by the recognition of the fundamental role played by two variables: the interactions among the units comprising the systems, and the interaction of the units with an external force field. In economics, if the units are firms, the first is called the "herd effect" (if one unit changes, other units influenced by that unit are more likely to change), and the second is called the "news effect" (all units respond to external news). The complexity of this picture is that the units do not simply interact with equal strength with a small number of other units, but rather have interactions of both sign ("ferromagnetic" and "antiferromagnetic") with other units...much as in an Edwards-Anderson spin glass except that the distribution of interactions is not known and will certainly even vary over time. Similarly, the interactions with "news" can take on a huge range of strengths–some news is very good, good, bad, or very bad–and news affects different firms differently...much as in a random field Ising model.

Of course this model is not exactly solvable, which makes it not very attractive to economists who generally prefer models that are amenable to solution. Nonetheless, it is attractive to physicists because we have developed a fairly deep understanding about phase transitions in idealized models, not only "pure" nearest-neighbor Ising models in a uniform external field, but also complex spin glasses and complex random field Ising models. Certainly we know enough to understand why the "globalization" of recent years might serve to introduce more "ferromagnetic" bonds, and hence to increase the magnitude of the sort of "spin flips" that occur in big clusters near the critical point. And Albert-László Barabasi has taught us that the networks formed by agreements among leaders of economic institutions serve to establish still more long-range ferromagnetic interactions, again with the result that cluster flips could be more dramatic.

Many physicists have viewed the film by Fumiko Yonezawa of her simulations below the critical point of Ising models with nearest neighbor interactions bathed in a uniform magnetic field. One can never forget how all the spins are flipping nonstop but suddenly a huge cluster of spins which were mostly "up" suddenly flip and become mostly "down". The effect of additional long-range ferromagnetic interactions would be to increase the magnitude of these dramatic flips.

In short, this physicist's intuition is that an overconnected system is WORSE, not BETTER, in a metastable condition, for encouraging large fluctuations. So if this argument has any validity, then the fluctuations are larger, not because of physicists making up new instruments, but rather because of the links between corporations, and the links between countries.

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