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# Westward Ho: April Meeting Descends on Denver

More than 1000 physicists will be on hand for the 2004 APS April meeting, to be held May 1-4 in Denver, Colorado. The April meeting traditionally covers a wide range of physics subfields, including astrophysics, nuclear and particle physics, the physics of beams, plasma physics, computational physics, gravitation, hadronic physics and few-body systems. There will also be numerous sessions on physics education and history. A special public lecture will be offered Saturday evening, May 1, on how the sun shines.

**The Case of the Missing Neutrinos**. In the mid-19th century, Charles Darwin and Lord Kelvin found themselves on opposite sides of a controversy regarding the age of the sun and the origin of solar energy. It would be over a century before physics had advanced to the point where scientists could postulate the existence of solar neutrinos, and detectors could be built to measure these elusive particles, which scientists believe are produced when the sun burns hydrogen nuclei to supply the sun's radiant energy. But far fewer neutrinos were observed than were predicted by theoretical models. The mystery of the missing neutrinos would not be solved for another three decades, when scientists discovered a dramatic solution in January 2001. The history of the neutrino problem, its solution, and subsequent research will be the topic not only of a special public lecture on Saturday evening by John Bahcall of the Institute for Advanced Study in Princeton, NJ, but will also be discussed by Fermilab's Boris Kayser, who will describe how neutrinos can morph from one "flavor" to another. In addition, a special Town Meeting entitled "Our Neutrino Future" on Sunday evening at 8 pm will feature talks by Stuart Freedman, Michael Turner and others, and provide ample time for audience participation. There is also an invited session on neutrinos on Sunday afternoon at 2:30 pm. [Public lecture and sessions H1, L4 and N1]

Photo Credit: Denver Convention Center

**Exploring the Solar Corona**. Despite being studied by physicists for more than a century, the dynamic microstructure of the sun's corona (usually visible during a solar eclipse) is only beginning to be revealed, according to Eugene Parker of the University of Chicago, who gave a Monday morning plenary lecture on the topic. The quest to glean more information about this mysterious gas is hampered by the limited resolution of existing telescopes. But now there is the proposed Advanced Technology Solar Telescope,

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## History in the Making

©2004 Paul Dlugokencky (aDailyCartoon.com) for *APS News*

*At the February Executive Board meeting, for the first time in APS history the presidential gavel passed from one woman to another. Shown here in an artist's rendering (based on a photograph taken by Michael Lubell), 2003 President Myriam Sarachik (right) hands the gavel to 2004 President Helen Quinn. Sarachik will deliver her retiring presidential address at the April meeting in Denver.*

## San Diego Hosts Second Biophysics Conference

The APS held its second topical conference on "Opportunities in Biology for Physicists" in San Diego, CA, from January 30 to February 1, 2004. Robert Austin (Princeton University) and Herb Levine (University of California, San Diego) co-chaired the Steering Committee for the conference, which was aimed predominantly at graduate students and postdocs in physics considering applying the methods of physics to biological topics.

In 2001, the APS Executive Board decided that it would be advantageous to organize a different kind of meeting, a topical conference on an emerging field, that would prepare physicists for future opportunities. Thus, a conference was organized focusing on the interface between physics and biology and aimed at early career physicists who were interested in exploring the possibilities of entering this exciting field. That first conference was held in Boston September 27-29, 2002 (see *APS News*, November 2002), and was very well received. A follow-up survey revealed a great deal of interest in a second conference.

The San Diego meeting kicked off with a session on bioinformatics, which employs tools from data mining and pattern recognition to make sense of the massive amounts of data collected by biologists on a daily basis. "Scientists can list all the pieces of DNA, but we have no idea how they all fit together; it's a giant jigsaw puzzle," said Edward Marcotte (University of Texas, Austin) by way of example. While the completion of the Human Genome Project represents a major step forward, there are roughly 40,000 genes in the human genome, and one third

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## Riordon Takes Over Media Relations Post

James Riordon assumed the helm of Media Relations at APS in February. He succeeds David Harris, who had served as Head of Media Relations since early 2002. Harris left APS to lead development of a magazine to be produced by SLAC and Fermilab for the particle physics community.

The media relations position was created on the recommendation of the APS Task Force on Informing the Public in 1999. Randy Atkins, now at the National Academy of Engineering, held the position from 1999 to 2001.

Riordon began his career in physics at the Naval Research Laboratory in Washington DC, where he designed and built instrumentation for a betatron accelerator that was being developed as an outgrowth of the Star Wars initiative in the 1980's.

"The intent was to build a high-current, lightweight, electron beam device the could be launched into orbit to shoot down ballistic missiles," says Riordon. "But at 7 tons, it seemed a little heavy for space flight. And as far as I know, they never managed to extract the beam from our machine."

Riordon left NRL in 1990 to join the Superconducting Super Collider's instrumentation group in Waxahachie, Texas as an applications physicist. There, he helped to develop beam current monitors and Faraday cups, and later specified lattices for beam transfer lines between the low and medium energy booster rings—just before funding was cut in 1992.

When the SSC shut down, Riordon returned to the Univer-

*See* RIORDON *on page 5*

## INSIDE THE BELTWAY:
### *A Washington Analysis*

## Cracks Begin to Show in the GOP Fortress

*By Michael S. Lubell, APS Director of Public Affairs*

Vernon J. Ehlers, the first professional physicist to serve in Congress, made unexpected news during the Republican retreat held in Philadelphia at the end of January. A fellow of the American Physical Society, Ehlers, who is in his sixth term in the House, serves the 3rd District in Michigan, which tilts strongly Republican.

Although Ehlers is a staunch environmentalist, the Republican House leadership generally considers him very much a team player. During the 107th Congress, according to the 2003 Almanac of Politics, he supported his party's leadership on most key votes, including tax cuts, campaign finance reform, faith-based charities, trade authority and the commitment of troops to Iraq.

So it came as a bit of a surprise when he challenged President Bush's political advisor, Karl Rove, over the White House economic message. According to *CQ Weekly* (February 14, 2004), the exchange went something like this.


Michael S. Lubell

Rove told his captive audience of Republican office holders that they needed to make sure their constituents got the word that the economy was recovering. Ehlers, who is not casually demonstrative, responded by holding up a copy of the *Grand Rapids Press* with the front page headline, "10 Days, 4,600 Jobs Lost."

According to *CQ*, Ehlers asked Rove, "What are we supposed to tell our constituents about that?" Rove had no compelling response, and as Ehlers noted afterward, "Nobody does." And that, any wise politico will tell you, poses a problem for office holders seeking another term.

As the President's approval ratings slip below 50% and national polls show Democratic presidential contender John Kerry ahead of the President among likely voters, GOP House and Senate members are beginning to wonder whether George W. Bush is going to be an asset or a liability in the 2004 election. That uncertainty could play a major role in

*See* BELTWAY *on page 2*

## Highlights



## Members in the Media

"Robots get smarter every day, while humans haven't changed in 35,000 years,"
*—Robert Park, University of Maryland, opposing human space travel, Philadelphia Inquirer, January 15, 2004*

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"There is no end to this wonderful world of experimental discovery and mental constructions and reconstructions of realities as new facts become known. That is why we physicists have more fun than most people."
*—Miklos Gyulassy, Columbia University, The San Francisco Chronicle, January 19, 2004*

✶✶✶

"The State Department needs people who understand the difference between research on something dangerous and basic research."
*—Daniel Marlow, Princeton University, on visa problems of foreign scientists, The New York Times, January 18, 2004*

"High energy physicists have been marching into our project. This is not just another telescope. It's a physics experiment, like a particle accelerator."
*—Anthony Tyson, Bell Laboratories, on a "dark matter telescope" known as the Large Synoptic Survey Telescope, The New York Times, February 17, 2004*

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"There's the question of whether magnetic fields are a risk and there's no compelling evidence to indicate that from the scientific literature I've read. One can never prove the absence of a small effect, but exposure to electromagnetic fields from power lines are typically less than from many other sources within the home or the workplace, such as TV's, microwave ovens, electric razors,

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## BELTWAY *from page 1*

the dynamics of the second session of the 108th Congress.

In fact, some might argue, the shift in the landscape is already evident. Here are two examples.

Shortly before the State of the Union Address, President Bush, amid great fanfare, unveiled his new vision for space: establishing a permanent base on the Moon and then sending astronauts off to Mars.

To say that Congress was unimpressed is an understatement. With the nation facing a budget deficit of $521 billion exclusive of any supplemental spending on Iraq, which won't be requested until after the November election—the exact amount cannot possibly be estimated until then—the bipartisan response from the Hill was a not so muted "Oof!"

The President had clearly laid a political egg. But he's savvy and recognized the error immediately. The grandiose plan never made it into his State of the Union speech. And it might even have been eliminated from his budget request, but, since the books were already being printed, we'll never know. The latest word is that Congress is likely to strip a good deal of the NASA money away from the project.

The congressional response to the presidential budget request offers a second example. The House GOP leadership, which has pretty much walked in lockstep with the Bush White House, has recoiled at the idea that the nation is on course to spend about $600 billion (including the presumed defense supplemental) that we don't have, and has put the Administration on notice that it plans to trim back the President's request, even for the Department of Defense.

Senate GOP leaders have proposed a different tack: their plan is to have no budget at all, until after the election. The technical way to achieve this is to pass a "Continuing Resolution." Senate insiders have suggested that a CR might extend for all of FY 2005, keeping spending frozen at FY 2004 levels.

Where does this leave science? In the case of the Department of Energy, a yearlong CR would protect the Office of Science from the 2% cut requested by the White House, although it might not permit any new project starts.

In the case of the National Science Foundation, a CR would strike the 2.2% increases for the various directorates. And for National Institutes of Standards and Technology, a CR would prevent Congress from ameliorating the pain created by the FY 2004 budget, which cut deeply into the NIST laboratories.

Whatever the outcome, it won't be pretty. Nor will it please most voters. But the choices are scant. So even if you're a novice at politics, this might be your year to run for office.

# This Month in Physics History

## *The Visionary*

### *May 2, 1519: Death of Leonardo da Vinci*

In 1994, multi-billionaire Bill Gates paid a record $30 million for Leonardo da Vinci's *Codex Leicester*. Heralded as the epitome of the "Renaissance man," da Vinci was known chiefly for artistic masterpieces like "The Last Supper" and the "Mona Lisa" until the 20th century, when monks exhumed and restored the *Codex* manuscripts in the 1960s. The sketches and notations depicted therein—all rendered in da Vinci's notorious backwards handwriting, readable only with the aid of a mirror—cemented his reputation as one of the greatest scientific minds of his era.

*Credit: American Museum of Natural History Library*

Born April 15, 1452, da Vinci was the illegitimate son of a Florentine notary, Ser Piero d'Antonio. Raised by his father, da Vinci received the standard education of the time—reading, writing and arithmetic—and when his latent artistic talents presented themselves as he approached adolescence, he was apprenticed to the renowned workshop of Andrea del Verrochio in Florence. There he learned painting and sculpture as well as useful technical and mechanical skills, such as grinding and mixing pigments, basic perspective geometry, and working with clay and bronze. By the time he was accepted into the painter's guild in 1472, he was already making sketches of pumps, weapons, and other ingenious machines in addition to his artistic pursuits. He would seek to balance those two interests throughout his life, with varying degrees of success.

In 1482, da Vinci entered the service of Ludovico Sforza, the Duke of Milan. Ironically, he earned the position by trumpeting his engineering skills and plans for designing advanced weaponry and fortified structures, rather than his skills as an artist.

The Duke kept him busy painting, sculpting and designing elaborate court festivals, as well as armaments, but da Vinci still managed to continue his studies in geometry by reading *Euclid*, Battista Alberti's books on architecture, and Piero della Francesca's *On Perspective* in painting, becoming so engrossed in the subject that he reportedly neglected his painting.

His real achievements in this period were scientific. He devised several methods of squaring the circle, relying solely on mechanical methods, and wrote a book around 1498 on the elementary theory of mechanics. He also foresaw the possibility of constructing a telescope in his *Codex Atlanticus* (1490) in which he writes of "making glasses to see the moon enlarged," although the device would not be realized for another 100 years. By 1513 he had expanded the basic concept, envisioning a means of projecting the image of a single planet onto the base of a concave mirror, the reflection of which would magnify the surface of the planet.

In 1499, French armies invaded Milan and the Duke was defeated, terminating da Vinci's employment with him. Now without a wealthy patron, da Vinci traveled first to Mantua, then to Venice, finally landing in Florence, where he focused as much attention on mathematical studies as he did on painting. By 1503 the city was under siege, so he concocted a grand scheme to divert the river Arno behind Pisa. He also produced plans for a canal to allow Florence access to the river.

His observations were often accompanied by precise illustrations of the objects or phenomena under analysis, along with explanatory notes, and over his lifetime he amassed volumes of such notebooks detailing studies ranging from astronomy and the formation of fossils to the growth of plants and action of light.

Like many artists and doctors of his day, da Vinci engaged in the practice of dissecting cadavers—as quickly as possible, given the lack of refrigeration and unavailability of formaldehyde in 15th century Italy—to study human anatomy, and this certainly influenced his art. But the scientist within him was equally intrigued by the structure of limbs and their dependence on nerves and joints, as well as the function of the cervical vertebrae, small organs, and capillaries. He was also enthralled by levers and gears, which lay at the heart of many of his sketched machines, including early prototypes of the bicycle, the helicopter, cranes, an automatic turnspit, an "auto-mobile," and weaponry like catapults, missiles, multi-barreled machine guns, grenades, mortars, and even a precursor to the modern tank.

His fascination with water, then the primary source of power, resulted in his design of advanced water wheels, a steam-powered cannon, and a device to measure humidity in the atmosphere. He also conceived of floating snowshoes to enable a man to walk on water; a life preserver to remain afloat; devices to attack and sink ships from underwater; and an "unsinkable" double-hulled ship, as well as dredges for clearing harbors and canals.

In 1513, his health beginning to fail, da Vinci moved to Rome. Three years later, he entered the service of King Francis of France (a great admirer) as first painter, architect and mechanic to the King. He died on May 2, 1519, in Cloux, France, at the age of 67.

Da Vinci was a rarity in his era for his emphasis on repeated testing of direct observations—a principle which underlies the method of scientific study that dominated well into the 19th century. For example, he undertook a systemic study of the flight of birds, and tried to apply those same principles in his designs for a flying machine. As such, da Vinci bridged the gap between an unscientific, highly superstitious medieval approach to scientific questions—which frequently bore more similarity to philosophy than science—and the empiricism of later ages.

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*Editor* ..... Alan Chodos
*Associate Editor* ..... Jennifer Ouellette
*Special Publications Manager* ..... Elizabeth Buchan-Higgins
*Design and Production* ..... Stephanie Jankowski
*Forefronts Editor* ..... Neville Connell
*Proofreader* ..... Edward Lee

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# Several APS Members Receive Honors

APS members have been honored with a variety of awards recently.

APS fellow **Rodolfo Gambini**, from the University of the Republic in Uruguay, was awarded the 2004 TWAS (Third World Academy of Sciences) prize in physics. In addition to his research in gauge theory, Gambini has been instrumental in rebuilding Uruguay's physics infrastructure. He founded a society for the promotion of science in Uruguay and has lobbied congress for a national research system.

"It is the first time that a scientist working in Uruguay has received a TWAS Prize. This award, therefore, not only recognizes a personal trajectory, but also the efforts that the national scientific community has made for the development of science in our country," Gambini said in a press release.

The TWAS Prizes for 2003 were announced on October 16, 2003, in Beijing, and will be presented at the next General Meeting of TWAS, scheduled to take place in Trieste, Italy, in November 2004.

APS Fellow **Rangaswamy Srinivasan**, of UV Tech Associates, formerly at IBM Research, was awarded the 2003-2004 AIP Prize for the Industrial Applications of Physics. The citation reads "for discoveries, inventions, and promotion of ablative photodecomposition for medical and materials applications."

Srinivasan was born in India in 1929 and came to the US in 1953 for his PhD at the University of Southern California. Srinivasan's discovery, a heatless laser surgery, has boomed into what's commonly known as LASIK. His invention of the method of lasers etching organic substances has also led to advances in communications.

The award, which is sponsored by the General Motors Corporation and AIP Corporate Associates, was presented at the 2003 AIP Industrial Physics Forum on October 27 in San Jose, California. Srinivasan also described his award-winning research at the 2004 APS March Meeting.

**Constantino Tsallis**, of the Brazilian Center for Research in Physics, in Rio de Janeiro, was awarded the Mexico Prize for Science and Technology for 2003. The prize was created in 1990 to recognize scientific and technological research conducted in Latin America, the Caribbean, Spain, and Portugal, and encourage links between those scientific communities and Mexico. It comes with $40,000 and is presented in a ceremony by the president of Mexico. This is the third time the prize has been given to a physicist. Tsallis was honored for his research in statistical mechanics.

Also, the APS topical group on magnetism has announced its first Outstanding Dissertation in Magnetism Awards. The three recipients were:

—**Gonzalo Alvarez**, a student at Florida State University working with Elbio Dagotto, "Computational Studies of Diluted Magnetic Semiconductors and Other Materials,"

—**Xin Jiang**, a student at Stanford University working with Stuart Parkin, "Tunnel spin injectors for semiconductor spintronics,"

—**Owen Vajk**, a student at Stanford University working with Martin Greven, "Quantum impurities in a two-dimensional antiferromagnet."

Alvarez, Jiang, and Vajk gave invited talks on their work at the APS March Meeting, where they were presented with their awards of $500.

# Physics Students Benefit from Virtual Study Lounge

Where can you access the latest in physics research and also vote on the best version of *The Matrix*? College students can check out The Nucleus [http://www.compadre.org/student/], a website that offers free interactive activities to help students share physics ideas.

"Our site doesn't really have any competitors," said technical lead Thad Lurie. "We just thought about the kinds of things physics students like to do, and made it happen." In the Nucleus, physics and astronomy students will find polls, reviews of college level textbooks, contests, job postings, the latest physics news, and even haikus.

"It was fun to see the responses from other colleges and to see some of the similarities. The University of Louisville has a professor that was referred to as 'the man,' while we at Juniata also have a professor who can be referred to only as 'the man'," said user Michael Best, a student at Juniata College, Huntingdon, PA, via email. "Beyond using The Nucleus as a research tool for summer employment, I have also used it as research for classes. The links section has several pages that are full of figures that I have included in lab reports and presentations."

"Without the interactions, we're a site providing useful content," said Lurie. "WITH the interactions, there is so much more—sure, we still have the content, but now we also have other students' opinions about the content, discussions about the content, questions about the content, materials that are related to the content."

The Nucleus is an entrance portal for a huge collection of physics resources called ComPADRE. Through The Nucleus, students can access everything in the ComPADRE resources database.

Also visitors can submit materials, which are reviewed by a committee before becoming part of the physics resources database.

The next ComPADRE portal to become public, The Quantum Exchange, will provide resources to help professors teach modern physics and quantum physics.

Other planned portals include

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## APRIL MEETING *from page 1*

a 4m ground-based instrument with adaptive optics capable of providing resolution down to 50 km [the corona has internal scales of 100 km or less], which will be combined with rapid cadence, high-dispersion spectroscopy to follow the action of the sun's corona. [Session Q1]

**Good Vibrations**. Sand, pharmaceuticals, cereal, cosmetics and asteroids are all examples of granular media, which are involved in many physical processes, although less understood than fluids and solids, according to Harry Swinney, who will give a plenary lecture on the spontaneous emergence of order in vibrated sand on Saturday morning. He conducts experiments using vertically oscillating granular layers, which have revealed a variety of spatial patterns emerging spontaneously as a result of the combination of container acceleration amplitude and frequency: stripes, squares, spirals, and hexagons, to name a few. These results correspond with computer simulations of the molecular dynamics of granular media. [Session A1]

**A New Look at Black Holes.** Recent discoveries have caused our assumptions about supermassive black holes to undergo a dramatic paradigm shift, according to speakers at a Saturday afternoon session detailing the discovery of these so-called "dark stars". They are notoriously difficult to detect because they emit no light of their own and can only be seen by their influence on nearby stars and gas. Speculations about the existence of black holes date back more than 200 years, but a theory did not appear until 1939. The theory gained wide acceptance with the discovery of quasars in 1963, and Cygnus X-1, the first bona fide black hole, was identified in 1972. Now, scientists believe that these objects may have been critical to the formation of structure in the early universe, spawning bursts of star formation and planets, according to Fulvio Melia of the University of Arizona, who will describe a possible black hole lurking at the center of the Milky Way. The University of Maryland's Cole Miller will speculate on possible new classes of black holes, such as solitary black holes and those with intermediate mass. He will also discuss the possibility of primordial black holes formed in the very early universe, which could be the primary components of the mysterious dark matter. Jeffrey McClintock (Harvard-Smithsonian Center for Astrophysics) will describe black hole x-ray binaries, and Omar Blaes (UC-Santa Barbara) will present the case for supermassive black holes being responsible for the prodigious power output of active galactic nuclei and quasars. [Session D3]

**String Theory Squares Off Against Newton.** Gravitation may be the oldest known interaction in physics, but it is still inspiring small-scale experiments to address such important open issues as why the force of gravity is so much weaker than other interactions, and why the cosmological constant is so small compared to the predictions of quantum mechanics. At a Saturday morning plenary session, Eric Adelberger of the University of Washington will discuss some of the techniques now being employed to test Newton's inverse square law, which some modern string theorists believe may break down at distances less than 1 mm, or even at solar system scales. These techniques include ultracold neutron technology, ultra-precise laser ranging of the moon, and extremely sensitive mechanical experiments with torsion oscillators and microcantilevers. [Session A1]

**Dirty Bombs**. So-called "dirty bombs"—technically known as radiological dispersion devices (RDDs)—are designed to spread intensely radioactive material with the intent to kill, sicken, or cause economic damage. The risks associated with RDDs have been somewhat overestimated by the government, even as they have been underestimated by physicists. As the tragic accident in Brazil demonstrated [see "The Back Page," *APS News*, March 2004], people in contaminated regions will inhale or digest dusty or liquid radioactive material in sufficient quantities to cause acute radiation sickness, and sometimes death. Speakers at a Monday morning session will provide a general overview of the nature and use of RDDs, the readily available sources of sufficient quantities of radioactive material, and the need to improve the security surrounding those sources to keep them from falling into the hands of terrorist groups. [Session R8]

**Radiation Detection**. Countries around the world are deploying radiation detection instrumentation to combat the illegal shipment of radioactive material crossing international borders by land, rail, air and sea. Speakers at a Sunday afternoon session will discuss the role of the physics community and radiation detection in preserving homeland security, as well as a new concept for an active neutron interrogation system that can detect small targets of contraband material even when shielded in thick Intermodal cargo containers.

Also featured in the session will be Yale University's Cornelius Beausang, who will describe his work educating and training first responders in radiation (see *APS News*, January 2004). [Session L2]

**Solar Flares**. Solar flares are known to release explosive energy in unconfined, magnetized plasma, and are generally believed to derive their energy from the sun's coronal magnetic field, but scientists are still trying to discover the release mechanism and how the energy is distributed among heating, particle acceleration, and mass motions. NASA's RHESSI mission is designed to study the acceleration and evolution of electrons and ions in solar flares by observing the x-ray and gamma-ray emissions these particles produce. Since its launch in February 2002, RHESSI has observed over 12,000 solar flares, according to NASA's Gordon Holman, who will describe how his team uses the RHESSI spectra to deduce physical properties of accelerated electrons and hot plasmas in flares. Other speakers will discuss high energy flare emissions and the study of solar flares in laboratory plasmas. [Session R3]

**All the President's Men**. Several former presidential science advisors will speak at a special Tuesday morning session devoted to tracing the history of that position from Franklin Roosevelt to the present. D. Allan Bromley (Yale University), and Jack Gibbons will describe their experiences and the issues that confronted them during their tenure, while Gregg Herken of the University of California will provide an historical perspective. Joel Primack of UC-Santa Cruz will round out the session with a talk on the AAAS Congressional Science Fellowship program and other efforts to engage scientists in informing the public and Congress about science. [Session V8]

**Correcting Misconceptions**. Among the biggest barriers to physics education is combating student misconceptions and faulty reasoning about basic physics tenets. Speakers at a Saturday morning session will explore such common misconceptions about the first and second laws of thermodynamics and electrical circuits, among other topics, and suggest approaches to combat those misconceptions. For example, students tend to have difficulty lighting a flashlight bulb with a 1.5 volt battery and a single wire, according to researchers at Kansas State University, apparently because they do not understand the bulb's internal wiring. The KSU scientists have designed experiments to alter that false impression. Similarly, David Meltzer of Iowa State University has found that students' difficulties with thermodynamics stem in part from the fact that heat, work and internal energy all share the same units. [Session B14]

## Special Events

**Saturday, May 1**
*Welcome Reception*
**5:30 am – 7:00 pm**
*Public Lecture*
"How Does the Sun Shine?"
John Bahcall, Institute for Advanced Study
**7:00 pm – 9:00 pm**

**Sunday, May 2**
*Meet the Editors*
**3:00 pm – 5:00 pm**
*Prize and Awards Presentations*
**5:30 pm**
*COM/CSWP/FIP Reception*
**7:00 pm – 9:00 pm**
*Neutrino Town Meeting*
**8:00 pm – 10:00 pm**

**Monday, May 3**
*Student Reception*
**5:30 pm – 6:30 pm**
**6:00 pm – 8:00 pm**

# LETTERS

## Indian Physicist Incarcerated for Four Years

I read the article by Ernie Tretkoff on the deportation of a physicist with great interest. You may perhaps like to learn of a case I got involved in a couple of years ago. It arose from a phone call to the physics department at the University of South Carolina, which I picked up more or less by accident. This led to a situation which would be unbelievable even in a Kafka novel.

The lady is of Indian extraction, but graduated in physics both in India and the Manchester University and Institute of Technology. She has worked in Saskachewan and the University of Arizona.

Somehow, she entered the United States illegally from Canada and was caught. The details of this are not clear to me, since she was here legally previously. She has now been incarcerated for upwards of four years, and is presently awaiting deportation to India. I intend this to be brief, so I won't go into details—such as how she got a black eye after being hit by an inmate at an institution where she was held here, which is a combination jail, hospital and lunatic asylum. I visited her weekly, and they kept her sedated on drugs. I am no psychiatrist, but she appeared normal and rational to me; especially when not on drugs. She had an English boyfriend in Canada, who is presently teaching English as a foreign language in Taiwan. Last week he came over here and married her, so when she gets back to India, she hopes to leave for Taiwan. I found her a most intelligent and interesting person.

Since she has no computer in jail, in communicating with her husband, she phones me and I email him. This should soon stop, since he now has a telephone. I would be happy to supply any more information should you desire.

Ron Edge
*Columbia, SC*

## Plea for Help is a Cop-out

I'm glad that the editors of the Zero Gravity column have recognized that the recent columns have been male-oriented, if not chauvinist.

I don't understand then why you chose to run another un-amusing and chauvinist article, "The Sleep-Retardant Properties of My Ex-Girlfriend". Despite your entreaty for submissions "from a female point of view," you don't seem to really care about making your column less male dominated.

Why does science humor have to have any relation to gender anyway? I enjoyed the column a few issues ago that had jokes about the differences between mathematicians, engineers, and physicists. I'm sure there is plenty of good-quality science related humor out there, and to point your finger at women and complain that we aren't providing any is really a cop-out.

Hoping you'll make me laugh again,
Ariel Michelman Ribeiro
*Bethesda, MD*

***Ed. Note:*** *This month's Zero Gravity is the first of a number that we received in response to our plea. We hope you like it.*

## Zero Gravity Equals Zero Morality

You reached a new low in your "Zero Gravity" of February 2004.

Apparently, because it is supposed to be funny, the "zero morality" you talk about is all right. I strenuously disagree.

Philip J. Hart
*Idaho Falls, ID*

***Ed. Note:*** *Readers who may have forgotten what was in the Zero Gravity in February can read it online at http://www.aps.org/apsnews/0204/020406.cfm .*

## New Science Needed to Achieve Hydrogen Economy, Says APS Panel Report

Significant scientific breakthroughs are needed for President Bush's $1.2 billion Hydrogen Initiative to succeed, according to a recent report by the APS Panel on Public Affairs (POPA).

The Hydrogen Initiative, which Bush announced in his 2003 State of the Union Address, envisions competitive use of hydrogen in commercial transportation by 2020, reducing the nation's dependence on foreign oil.

The POPA report, released March 1, concludes that more basic scientific research is needed to reach that goal.

The report points out that there is no currently available means of efficiently, cleanly, and economically producing hydrogen. Current methods of hydrogen production are four times more expensive than gasoline. Also, a new material is needed to construct a hydrogen fuel tank that meets consumer benchmarks. "The most promising hydrogen engine technologies require factors of 10 to 100 improvements in cost or performance in order to be competitive."

Simple incremental advances cannot close these performance gaps, states the report. "The only possibility for narrowing the gap significantly is a program of high-risk/high-payoff basic science that is coupled to applied programs. The objective must not be evolutionary advances but revolutionary breakthroughs in understanding." To achieve these breakthroughs, more basic research is required. The Hydrogen Initiative places too much emphasis on demonstrations and not enough on basic science, says the POPA report.

The report notes that the nation's basic science agencies—the National Science Foundation and the Department of Energy's Office of Science—did not receive support from the hydrogen initiative for FY'04. The FY'05 budget request does include $29 million for basic research in the Office of Science. The report calls this an improvement, but says it "still does not reflect adequate appreciation that the large performance gaps can only be reduced by major scientific breakthroughs."

In addition to a greater emphasis on basic research, the report calls for increased focus on "bridge technologies" such as hybrid gas/electric vehicles that can reduce pollution and dependence on foreign oil while competitive hydrogen vehicles are still being developed. "Bridge technologies would serve as a sensible hedge to the possibility that the 2020 goal may slip. "

This is not the first study to highlight the gap between current hydrogen technology and the goals of the Hydrogen Initiative. A report from the DOE Basic Energy Sciences Workshop released in 2003 also concluded that significant advances in basic science are needed (See *APS News, November 2003)*. In February a National Research Council report made similar points, concluding that the development of hydrogen-powered cars would probably take longer than previously estimated.

In developing the POPA report, the authors reviewed analysis presented in the DOE and NRC reports and other sources.

The report does not imply that hydrogen engines will not work. With significant advances, the report states, "hydrogen has the potential to be economically produced in the future from renewable sources. If major scientific challenges to storage and use can be overcome, hydrogen fuel also has the potential for addressing the Administration's goal of enhancing energy security by reducing dependence on imported oil. Further, depending on the manner in which the hydrogen fuel is produced, hydrogen fuel can significantly reduce atmospheric release of carbon dioxide."

The full report is available at http://www.aps.org/public_affairs

**LOUNGE** *from page 3*

teaching materials for introductory college astronomy, high school physics teachers, and informal education.

"The Nucleus is important to the future of physics in general, because it provides a community meeting place for a small and often isolated, but important, segment of society," said Gary White, the director of the Society of Physics Students.

The site has registered 500 users since its rollout in late December. The website is a project of the American Association of Physics Teachers in conjunction with the Society for Physics Students and is funded by the National Science Foundation.

— *Inside Science News Service*

# Ask the Ethicist

***Editor's Note:*** *Please send ethical questions for Jordan Moiers or comments to: ethics@aps.org, or by mail to Jordan Moiers, c/o APS News, One Physics Ellipse, College Park, MD 20740. Contributors should identify themselves, but their names and addresses will be held strictly confidential unless they request otherwise.*

*The opinions expressed in this column are not necessarily those of either the APS or* APS News.

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"A couple of years ago I was writing a paper and disliked the look of a figure a collaborator had made. Since I had set up the apparatus he was using, I knew how to access the raw data and downloaded it in order to make a more attractive plot. When I did so, I was shocked to see that the data that were presented in the figure as being from one specimen were actually from three different specimens. He had created a false impression of reversibility by gathering together data that were actually on different samples.

At this point I was faced with an ethical dilemma: I could confront the co-worker and ask him for an explanation; I could denounce him openly and demand that he retract his paper; or do nothing. In fact I did nothing but tell another co-worker about the incident. I didn't confront the fabricator because I wasn't interested in hearing his concocted explanation. The problem of retraction of the paper was a more difficult question since like others I wish that the published literature was free of falsehoods.

However, the published result was fairly obscure and appeared in a widely unread conference proceeding, not a refereed journal. In the end, I couldn't see what a confrontation would accomplish except create hard feelings. Was my decision wrong?"
**(Name and address withheld)**

**Jordan Moiers responds:**

In a nutshell; yes, your decision was wrong. But you don't really need me to tell you that, do you? (After all, you were shocked by your co-worker's data manipulation.) To quote the APS Ethics guidelines "All coauthors have an obligation to provide prompt retractions or correction of errors in published works. Any individual unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor."

It's often difficult to take the high ethical road, but you should certainly have done something: confront your co-worker, involve your supervisor, retract the paper, or withdraw as coauthor.

The implicit question you're asking is "how wrong was it to do nothing?" On the Richter scale of ethics violations, yours was small. The ethical tremors that result from an indiscretion in a paper in an unrefereed, widely-unread collection of conference proceedings are probably undetectable outside of your small corner of the research community. Bear in mind, however, that you are at ground zero. A widely-unread paper is, by definition, narrowly read—by your colleagues, supervisors, students, and possibly even friends

*See* ASK THE ETHICIST *on page 5*

*The recent APS Task Force on Professional Ethics recommended that APS work with physics departments to improve education on ethical issues that affect the physics community. If you have experience or interest in developing materials to help students understand and confront such issues and would be willing to help with this task, please contact Ken Cole, Special Assistant to the Executive Officer, at* cole@aps.org.

# Cooper is New OPA Fellow

The APS has hired David Cooper as a science policy fellow in its Office of Public Affairs in downtown Washington, DC. Cooper replaces Susan B. Ginsberg, who is now at the Department of Homeland Security's Science and Technology Directorate. He will work with the OPA staff to advance science policy issues on Capitol Hill, focusing on the federal budget for science and technology research and on education issues.

"It was a very natural step," says Cooper, who comes to the APS after four years working on science policy issues at the American Association for the Advancement of Science's Center for Science, Technology, and Congress. His duties included holding briefings for congressional staffers, producing a newsletter on science policy issues, and undertaking other activities aimed at raising visibility of the scientific community and increasing their impact on the Hill.

He will be doing similar things for the APS, but is looking forward to focusing on more specialized topics. "AAAS was very broad in scope," he says. "One day I'd be working on stem cell research, another on NASA, and a third day on K-12 education. It was a great experience, but I'm ready to narrow the focus."

Cooper earned his B.A. in physics from Haverford College, after considering a major in political science. He wasn't sure he wanted to pursue graduate studies in physics, and opted to spend a few years in DC, combining his love for science with his interest in politics. "I wasn't sure if this was something I wanted to do long term, but it's worked out well for me," he says.

# Four Divisions in Sweeping Attack on Neutrinos

*By Ernie Tretkoff*

The APS Divisions of Astrophysics, Nuclear Physics, Physics of Beams, and Particles and Fields have begun a sweeping study of neutrino physics. The study, which is still in its early stages, will cover everything from astrophysical neutrinos to accelerator experiments.

Recent discoveries, especially the compelling evidence for neutrino oscillation, prompted these APS divisions to embark on the study in order develop a coherent plan to guide further neutrino research. Study organizers hope to have a final report by the end of the summer.

"I think neutrino physics is genuinely exciting," said Boris Kayser, who co-chairs the study with Stuart Freedman. "Really beautiful experiments have gotten convincing evidence that neutrinos change from one flavor to another, and that means they have nonzero masses. This does raise some very interesting physics questions, and we want to go ahead and answer those questions, but we need to have a coherent plan for doing that."

The study aims to lay a plan to answer some of the open questions in neutrinos physics. According to Kayser, a few of these important questions are: How many neutrino species exist? Are there sterile neutrinos? Are neutrinos their own anti-particle? What is the scale of the neutrino mass? What physics is responsible for neutrino masses and mixing? Do neutrino interactions violate CP? The study members hope to come to a consensus, if possible, about what measurements should be made to answer these questions. According to the charge of the study "the study will lay the groundwork for the choices that must be made during the next few years."

The study will not evaluate or rank specific proposals, but will investigate what physics questions are most important and what are the most promising ways to search for answers. Funding agencies may then consider those guidelines when allotting funds to various proposals, said Kayser.

The study is divided into six working groups, each focused on a particular experimental approach. The working groups are: Solar and atmospheric neutrino experiments; Reactor neutrino experiments; Superbeam experiments and development; Neutrino factory and beta beam experiments and development; Neutrinoless double beta decay and direct searches for neutrino mass; and What cosmology/ astrophysics and neutrino physics can teach each other.

"The most interesting aspects of this study may be understanding how the different experimental approaches of the different groups fit together." said Ed Blucher, one of the leaders of the reactor working group.

The study began with a kick-off meeting at Argonne in December. Most working groups are still in preliminary stages. All groups have had their first meeting and have selected questions the group hopes to answer; some groups have already outlined their report. The study organizing committee and the working group leaders will meet in April to determine whether the study is on track.

At the APS April Meeting there will be a Town Meeting on "Our Neutrino Future," that will include a talk by Freedman on the status of the study and opportunity for discussion.

The final report, which will be completed this summer, will include contributions from individual working group members, a summary for each working group, and an integrated summary of the whole study.

"We need to have a coherent plan, and if possible, it should enjoy at least some degree of community consensus. Now that is very nontrivial to achieve," said Kayser. "This is very hard, and also very important, so we're going to try."

Kayser also hopes the study will do some outreach, possibly in the form of a glossy brochure for the general public, or a "neutrinofest" conference, in which scientists would give talks to a general audience, with a large media presence, to convey the excitement of neutrino research.

# APS Helps Local Organizers In State Battles on Evolution

*By Ernie Tretkoff*

In the ongoing battle between evolution and creationism in schools, the APS has been working on this issue by monitoring developments and by assisting members who want to organize on a state or local level.

The issue has re-emerged recently as several states reviewed their textbooks or statewide science standards. Anti-evolution groups have tried to push for textbooks or lesson plans that criticize evolution and teach creationism or the related movement, intelligent design. This movement asserts that an "intelligent designer" is needed to explain the complexity of life on Earth, but does not say anything about the identity of the designer.

Last summer, a resolution came before the Louisiana House Education Committee requiring a balance between evolution and creationism in school textbooks. The APS closely watched the issue and raised people's attention, but the resolution was dropped before it even came to a vote, said Francis Slakey, APS associate director of public affairs

Also last summer, New Mexico conducted a review of its classroom science standards. The Discovery Institute, an anti-evolution organization, ordered a poll that suggested that many scientists support teaching intelligent design. The APS, together with AIP, then wrote a letter to the Board of Education, pointing out that the Discovery Institute poll misrepresented scientists' viewpoints and fell short of normal polling standards. The Board of Education voted unanimously to continue teaching evolution in an undiluted manner, rejecting the changes the anti-evolution groups wanted.

Last fall the Texas board of education voted on which biology textbooks to approve. The Discovery Institute pushed for textbooks that included what they called weaknesses in the theory of evolution.

The APS alerted C.A. Quarles, chair of the Texas section, and suggested that he help collect signatures for a letter to the board of education. About 550 of the approximately 1200 Texas members added their signatures to the letter, which urged the board to "choose only textbooks that present accepted, peer-reviewed science and pedagogical expertise."

The high response rate indicates how important the issue is to scientists, said Slakey. "One thing we learned from Texas is there are plenty of people in the physics community who are impassioned about this issue and willing to take action."

Physicist Steven Weinberg even testified before the board. "I think it is your responsibility to judge that it is the theory of evolution through natural selection that has won general scientific acceptance. And therefore, it should be presented to students as the consensus view of science, without any alternatives being presented," he said in his statement. In the end, the board voted 11 to 4 to accept textbooks teaching only evolution.

Quarles called the letter effective. "I think it was a good strategy," he said, "I would encourage other states to do it as the issue comes up." The issue does keep coming up.

Earlier this year, Georgia revisited its state science curriculum.

*See* EVOLUTION *on page 6*

## RIORDON *from page 1*

Photo Credit: Alan Chodos

*James Riordon and friend*

sity of Maryland at College Park, his alma mater, to join the Ion Beam Laboratory at the Institute for Plasma Research.

"We primarily focused on developing ion beam machines for high resolution lithography. It was interesting research, but after a few years I learned that I wasn't cut out for meticulous lab work."

One incident in particular left a lasting impression on Riordon. "I was working alone in the lab, trying to get the source for one of our beam machines going. I got tired of perpetually shutting down the system to make adjustments, and foolishly disabled an interlock system that was designed to shut everything off if a lead-lined enclosure was opened. Sure enough, I mistakenly opened the enclosure door while the source was operating and the Geiger counter I was carrying went off the scale, indicating that I had received what I believed to be a lethal dose of x-rays. I thought it was all over."

Riordon recalls that he turned off the source, and spent about ten minutes trying to decide whether to call an ambulance, or to live out his final hours visiting with his son at the campus day care and calling loved ones to say good-bye.

It was, says Riordon, the longest ten minutes of his life. "I decided instead to confirm my impending demise by turning on the source again to see what sort of a dose I had accumulated. Fortunately, it turned out that I'd had the counter turned to the most sensitive scale, and when I adjusted it properly I found that I had been exposed to relatively little radiation. It was clear that I was going to live. . . and equally clear that I was too impetuous to work around dangerous machinery."

Although he continued at the lab for several more months, the incident inspired Riordon to begin looking for safer job options. "I had been writing plays and freelance science articles on the side, and realized that the best way to combine my love of physics and writing was through a career as a science journalist."

Following a brief stint as an associate editor for the American Chemical Society's journal *Analytical Chemistry*, Riordon turned to freelance science writing full time.

"Freelancing is a tough way to start a writing career; I had an incredible amount of freedom to choose the topics that interested me, but much of my time was dedicated to pitching story ideas and marketing my work," he says. "There are few things I've enjoyed more than walking into a library or bookstore and seeing my work in a copy of *New Scientist* or *Popular Science*."

He eventually joined the American Institute of Physics media team, where he contributed to the venerable AIP newsletter *Physics News Update*, helped manage news rooms for AIP member society meetings, and worked to publicize the physical sciences through AIP's *Inside Science News Service* and the *Discoveries and Breakthroughs Inside Science* television spots. All the while, he continued freelance science writing, and was a frequent, freelance contributor to *APS News* and the APS educational web site PhysicsCentral.

Just prior to taking over the Media Relations position at APS, Riordon proposed one of the cornerstone projects in the APS contribution to the upcoming 2005 World Year of Physics (WYP2005) celebrations.

"I've always been a fan of distributed computing efforts, like SETI@Home," he said. SETI@Home is a project that searches data from the Arecibo Observatory for signs of extraterrestrial intelligence. "For a long time now," says Riordon, "I've been trying to think of other, physics-related, distributed computing applications." Einstein@Home, the WYP2005 distributed computing project, will analyze data from the Laser Interferometer Gravitational Wave Observatory (LIGO) in a whole-sky search for gravitational waves from pulsars.

"Einstein@Home has taken on a life of its own; I suggested the idea to [APS Associate Executive Officer] Alan Chodos and called a few people. But members of the LIGO Scientific Collaboration, Peter Saulson and Bruce Allen in particular, have done the real work to get it going. All we at APS have to do is make sure that a million people or so take part in the project."

"Ensuring the success of WYP2005 is going to be a large part of my job at APS for the next two years," says Riordon, "in addition to trying to follow the stellar examples of Randy Atkins and David Harris in fostering media coverage of physics." But working with APS members and staff means I'll always have excellent material to offer the media."

## ASK THE ETHICIST *from page 4*

and family. In short, the only people likely to read the paper are probably the people most important in your life and career. Maybe you'll be lucky and nobody will ever read the paper. What the heck, why not "strive" to write papers that will never be read at all? Even better, you could choose to work on unimportant research, write low-quality papers, and bury them in a hole where they'll never see the light of day.

I hope you would rather strive to contribute to the advancement of science. There is a saying among theater folk that there are no small roles, only small actors. The same is true of research and researchers. Your co-worker has shown that he is one of the small researchers. You are in danger of going down the same path, so long as you act as though your work is too trivial to rise to accepted ethical standards in physics. It may be too late to correct the paper you published in the obscure conference proceedings, but it's not too late raise your own ethical standards.

## BIOPHYSICS *from page 1*

to one half of those have completely unknown functions. "Thus far, we have successfully defined our ignorance," Marcotte joked.

Another area ripe for contributions from physicists is systems neuroscience, the subject of Saturday morning's session, which focused on two broad themes: (1) notions of learning, and (2) the emerging concept that the nervous system is not, as previously believed, about taking in information and processing it, but about transforming input information into a single binary decision. To that end, MIT's Sebastian Sueng described his work on the dynamics of neural networks and the concept of "reinforcement learning".

Computer scientists view learning as optimization, but Seung has proposed a new concept: learning by noise injection. He believes learning derives more from exploiting randomness.

His thesis is modeled on how birdsong is learned and generated, and draws on basic signal processing: birds seem to employ the equivalent of a nonlinear oscillator.

This is partially innate and partially acquired behavior. A male baby bird listens to his father's birdsong to form a template memory of the sound. Then the baby bird learns through trial, error, and iteration to reproduce the stored template sound; over time, his attempts improve thanks to repetition combined with auditory feedback.

To test his hypothesis, Seung constructed an experiment using a computerized "Frankenbird", which was "taught" by a recorded "tutor" of actual birdsong. While the final result was not an exact match, Frankenbird's song did show significant improvement over time.

Princeton University's Bonnie Bassler has been featured recently in both *Nature* and *Scientific American* for her potentially revolutionary work on cell-to-cell communication, which formed the basis for her Saturday afternoon lecture.

According to Bassler, bacteria have developed a chemical language, via the exchange of chemical signals, with the various chemicals representing "words," enabling individual bacteria to coordinate expression on a multi-organism scale. An example of this is the phenomenon of "quorum sensing" in various microbial life forms.

Bassler's research has focused on *v. harveyi*, a bacterium that seeks out other bacteria in order to clump together. When a critical threshold is reached, all the bacteria simultaneously activate an enzyme that causes them to glow.

Quorum sensing has also been observed in *p. aeruginosis*, which releases virulent pathogens when that critical threshold is reached. Although this field is only about 10 years old, there are some emerging applications in the pharmaceutical arena: designing drugs to block production of the critical enzyme, thus disabling the cell communication network of bacteria that emit dangerous pathogens.

Austin—Bassler's Princeton colleague—closed the session by describing his work studying chemotaxis and quorum sensing in *e coli*.

Other topics featured during the workshop were the specific neural mechanisms of perceptual learning; optical studies of direction selective cells in the retina; how microbial rhodopsins transduce light into biological energy and information; the packaging of DNA by single particles of bacteriophage; the use of DNA microarrays to infer genetic networks; engineered gene circuits; single molecule detection using nanoscale electronic devices; applications for biological polymers; and pattern formation and self organization.

Everyone agreed that ultimately, the distinction between physics and biology is arbitrary and largely meaningless. "Chemists never ask, 'Is this really chemistry?' But physicists are obsessed with this question," said Andrea Liu, a panelist from the University of California, Los Angeles. "The two fields should not be divided," agreed fellow panelist Valery Kalatsky (University of California, San Francisco). "Ultimately it's about interesting scientific questions." Moderator Jose Onuchic (UCSD) drove home this point: "At UCSD, we want the interface to thrive without all this quibbling about physics and biology labels."

An afternoon reception on the first day provided an opportunity for those researchers in biological physics and those who hire biological physicists to meet with the participants and to display posters or provide information in other forms.

There was also a "Lunch with the Experts" for student participants free of charge. Workshop attendance was once again limited to about 250 participants, in order to ensure better interaction between speakers and participants. External funding for the workshop (including travel grants for students in need of financial aid) was provided by NIST, NSF, DOE, the Office of Naval Research, and NIH, as well as Burroughs Wellcome and the Sloan Foundation.

Videotaped lectures and accompanying slides from the "Opportunities in Biology for Physicists" conference in San Diego can be found online at www.aps.org/meet/biology physics2/weblectures.cfm.

zero gravity

The Lighter Side of Science

# The Historical Discovery of a New Element, Orodruinium*

*P. Legolas, Mirkwood Academy of Science*

**Abstract:** The author sets forth experimental evidence for the discovery of a new chemical element, tentatively named Orodruinium. The curious properties of this new element are described.

**1. Introduction:**

A careful reanalysis of Third Age historical documents provides evidence for a hitherto unknown chemical element. This evidence centers on an ancient artifact known as the Annulus Unus (One Ring). Unfortunately, this priceless antiquity was destroyed in an unfortunate ledge-dancing incident in 3019 TA [1] (which also claimed the life of one S. Gollum).

However, sufficient historical documentation remains to propose the existence of a new element, out of which the One Ring was composed, and to list the unique properties of this material.

**2. Background:**

The One Ring was created by D.L. Sauron out of a substance once widely believed to be gold. The smelting was done in a forge inside the Sammath Naur, the central vent of a volcanic peak in Mordor known as Orodruin, or colloquially "Mount Doom." Orodruin has a central peak height of 4500 feet and a morphology commonly interpreted as belonging to the stratovolcano or composite cone classification (Fonstad, 1991). However, the lava of this volcano is widely known to be hotter than that of any other known terrestrial igneous structure and hence it was only in this specific lava that the One Ring could be destroyed (Gandalf and Elrond, 3018 TA)

The hottest known lavas are currently of the basaltic variety, with temperatures typically of 1300 –1450 K. (McEwen, 2002) Therefore the temperature of Orodruin's lava is, by definition, above this temperature range.

It is widely understood that basaltic flows usually produce the broad, gently sloping structures known as shield volcanoes, a distinctive morphology unlike that of Orodruin.

However, alkali basalts can produce massive cones such as Kilimanjaro in the East African Rift System (Gunn, 2003). The abnormally high temperature reported for Orodruin is reminiscent of that found in Io's volcanoes, where temperatures of approximately 1800K were measured by the Galileo spacecraft in 1997 (McEwen, 2002).

Such abnormally high temperatures are similar to those proposed for terrestrial volcanoes during the Paleoproterozoic and earlier ( age > 2 B yrs). Ancient terrestrial high temperature lavas appear rich in magnesium, as Galileo data suggests are those of Io (McEwen, 2002). Therefore, ultramafic lavas could explain the unusual temperatures reported for Orodruin. However, it is possible that the presence of an element other than magnesium might be responsible for the distinctive thermal properties of Orodruinian lava—namely the proposed element. It is for this reason that this new element has been dubbed "Orodruinium".

**3. Properties of Orodruinium:**

*Abundance*—Orodruinium has only been reported in Orodruin, hence making it the rarest of terrestrial elements. Its extraterrestrial abundances are unknown, although it appears to not be an important component in known meteorites.

*Melting point*—This is estimated to be approximately 1800 K, based on the previous discussion on Orodruinian lava.

*Atomic mass*—Orodruinium is the only known element to have a variable atomic mass. Experimental evidence supplied by F. Baggins (Gamgee: 60 FA) attests to astounding changes in the apparent mass of the One Ring. This is corroborated by private communications from B. Baggins (Gandalf). Curiously, the atomic mass seems inversely proportional to the distance between the One Ring and Orodruin. The actual relationship may be more correctly an inverse square law, however the paucity of experimental evidence does not allow for a more precise definition.

*Elastic properties* —Orodruinium has elastic properties greater than any other known solid element. Experimental evidence provided by B. Baggins (personal communication with W. Gandalf) demonstrates that the One Ring "shrank or expanded in an odd way." Further evidence is provided by the fact that the One Ring was apparently able to snugly fit the fingers of any of five individuals of various biological types —D.L. Sauron (*Maia diabolus*), F. Baggins, B. Baggins, S. Gollum ( *Homo sapiens periannath*)[2], and K. Isildur (*Homo sapiens numenorean*)—in a matter of seconds. These remarkable elastic properties deserve further study, resulting in undoubtedly numerous technological applications.

*Stability*—Orodruinium is at least approximately stable over the observed lifetime of the One Ring (5860 years). However, there is evidence suggesting that the element does emit harmful radiation of a possibly unknown variety.

Four of the six individuals who were in the possession of the One Ring suffered from troubling symptoms reminiscent of radiation poisoning, including hair loss, weight loss, reduction in appetite, insomnia, and in the most extreme case (S. Gollum) the severe malformation of limbs and facial features. The most curious physiological effect seems to be an uncomfortable and unnatural longevity, described by one victim (B. Baggins, personal communication with W. Gandalf) as feeling "thin and stretched." Victims of Orodruinium exposure also suf-

*See* ZERO GRAVITY *on page 7*

## EVOLUTION *from page 5*

State Schools Superintendent Kathy Cox initially recommended removing the word "evolution" and some of its concepts from the standards, but later changed her mind. The APS, along with other scientific societies, wrote a letter urging the Board of Education to adopt standards that teach evolution in its entirety, and on February 12, the State Board of Education announced its plan to include a full treatment of evolution in the standards.

In February the Ohio Board of Education voted 13-4 to give preliminary approval to science lesson plans that include "critical analysis of evolution," which some scientists fear could be an opening to teach intelligent design. In Missouri, the House of Representatives is currently considering a bill that would require intelligent design to be given equal treatment with evolution in science classes.

Though evolution is a topic in biology, not physics, it's an issue that all scientists can get involved in. "I think this is an issue that everyone should care about. I think that physicists can speak out on this. It doesn't have to be just the biologists who speak out," said Quarles. "You don't have to be a biologist to make a judgment about good science versus bad science."

The APS statement on creationism, adopted in 1981 and reaffirmed in 1997, reads, in part, "We strongly oppose any requirement for parallel treatment of scientific and nonscientific discussions in science classes.

Scientific inquiry and religious beliefs are two distinct elements of the human experience. Attempts to present them in the same context can only lead to misunderstandings of both."

Slakey emphasized that members who want to take action in their own state can contact the APS for support. "It's a structure that's available to anyone who's concerned that something's popping up in their state, " he said, "We provide assistance, but it's really locally based, with us just providing the logistical support."

# ANNOUNCEMENTS

## Issues and Actions

### ISSUE: RESEARCH FUNDING

**Research funding is down by 2% at the Office of Science, up by 2% at NSF in President Bush's proposed budget.** Released February 2, the budget for fiscal year 2005 includes a $521 billion deficit and increases for national defense and homeland security spending. As a result, science programs across the federal government are feeling the squeeze. The DOE Office of Science receives a 2% cut, physical science research at the National Science Foundation goes up by roughly 2%, and basic research at the Department of Defense falls 5%. Over the next few months, Congress will begin crafting appropriations bills using the President's budget as a starting point.

**ACTION:** Log on to the APS Web site (*http://www.aps.org/public_affairs*) and write to Congress stating there needs to be a strong investment in science.

### ISSUE: DEFENSE

**Congress is considering whether to construct a Modern Pit Facility capable of manufacturing plutonium pits for nuclear weapons at an estimated cost of $2 to $4 billion.** An APS panel assessed the need for a MPF. They concluded that there is insufficient technical reason for the Federal Government to select a site or commit to a Modern Pit Facility design at this time. Please check the POPA web page for postings at *http://www.aps.org/public_affairs/*

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### ISSUE: ENERGY & ENVIRONMENT

**President Bush has proposed a $1.2 billion Hydrogen Initiative that has a goal of developing a hydrogen-fueled car** and supporting infrastructure by the year 2020. An APS panel assessed the initiative and concluded that there needs to be more emphasis on solving fundamental science problems. Would you like to read more? The full report is on our web site at *http://www.aps.org/public_affairs/*

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### ISSUE: EDUCATION FUNDING

**On the issue of creationism**, Georgia has reversed the recommendation to omit the word evolution from school science classes. The word is back in the science curriculum.

**ACTION:** If this is an issue in your state, alert our office at slakey@aps.org or (202) 662-8700.

**The President's budget would move the peer reviewed Math and Science Partnerships program at the National Science Foundation to the Department of Education,** which currently funds another partnerships program that distributes funds to each state. APS has joined a group of societies to oppose this change. Our letter to Congress is available on the APS Web site (www.aps.org/public_affairs).

## WHO'S HIRING PHYSICS BACHELORS IN YOUR STATE?

Visit: www.aip.org/statistics/whohires

A state by state listing of the many companies that recently hired new physics bachelors. Includes the names of employers in 31 of the 50 states.

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## New Job Web Site for APS

If you're looking to fill or find a job, the new APS Online Job Center at **http://careers.aps.org** is your one-stop shop. Jobseekers and employers alike will find the APS Job Center, which now receives over a million hits from 20,000 unique visitors monthly, to be an invaluable resource.

The APS Job Center contains hundreds of new jobs posted monthly and offers a database of thousands of resumes. It covers all physics fields plus related fields such as materials science, computing, biology, chemistry, and engineering.

### EMPLOYERS

Whether you're an HR manager or a member of technical staff looking to hire, you can take advantage of valuable services for a low cost.

For example, you can:

- Post multiple job descriptions
- Receive job applications online
- Track how often your job is viewed
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- Create automatic job alerts—you'll be contacted as soon as your dream job is posted.

If you have any questions about any of the services, please contact us at **jobs@aps.org.**

## 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.

**Inhomogeneous superconductivity in condensed matter and QCD**
*—Roberto Casalbuoni and Guiseppe Nardulli*
Fermi liquids may undergo a superconducting phase transition even if the densities of the femions to be paired are different. In such cases, the pairing field would be inhomogeneous and the system would have crystalline properties. This review presents the general theory of such phases, starting from the first theoretical descriptions in the 1960s. The Modern formalism of effective field theory is found to be especially useful to describe the possible superconducting states in such diverse systems as organic superconductors or quark matter in neutron stars.

## MEMBERS *from page 2*

and electric blankets."
*—Rick Matthews, Wake Forest University, on possible risks of living near power lines, Winston-Salem Journal (Winston-Salem, NC), January 8, 2004*

✶✶✶

"What we are seeing here, and we have not seen it before, is an administration that distorts the process by which it gets advice and censors the advice it gets from its own scientists."
*—Kurt Gottfried, Cornell University, on a report by the Union of Concerned Scientists, Los Angeles Times, February 19, 2004*

✶✶✶

"In many ways these two frontiers are driven by different philosophies. One is to get a bigger and bigger hammer to smash things, and the other is to get things quieter and quieter so you can listen better."
*—Eric Cornell, University of Colorado and NIST, comparing high-energy and low-temperature physics, Philadelphia Inquirer, February 16, 2004*

✶✶✶

"The bottom line is that it's going to be at least two or three decades before there's any significant number of fuel cell vehicles out there being bought by the public, and that's the optimistic scenario, if all goes well and the research challenges are met."
*—Antonia Herzog, Natural Resources Defense Council, on hydrogen-fueled cars, San Francisco Chronicle, February 9, 2004*

✶✶✶

"Scientifically, just for the pure science of it, wouldn't you like to know just how many chemical elements there are? And until you actually have a measurement that you believe and you can confirm, you don't have any idea whether the various models the theorists propose have any meaning at all."
*— Darleane Hoffman, University of California, Berkeley, on the production of elements 113 and 115, The New York Times, February 1, 2004*

✶✶✶

"I don't see the smoking gun. It has been known for years that they have a research and development program with centrifuges and that was somewhat tolerated. But the really important thing is whether they have made the jump from R&D to a plant that could make a bomb or more a year, and there really isn't as much evidence as one would think to support that."
*— David Albright, Institute for Science and International Security, on North Korea's nuclear program, Los Angeles Times, February 24, 2004*

## ZERO GRAVITY *from page 6*

fer from psychological effects, ranging from simple irritability to paranoia, multiple personality disorder, and occasional hallucinations of disembodied eyes wreathed in flames. The most extreme case (S. Gollum) also involved a curious and pathological misuse of first person pronouns, suggesting that Orodruinium affects the areas of the cerebral cortex found by Sakai et al. (2001) to control grammatical structure.

The effects seem to rely on a cumulative dosage, with those of longer exposure suffering the greatest effects. The exception seems to be D.L. Sauron, who was in possession of the One Ring for 1841 years (compared to S. Gollum's 487 years, B. Baggins' 60 years, and F. Baggins' 18 years [3])

However, since there is no evidence as to D.L. Sauron's baseline physiological and psychological parameters prior to possessing the One Ring, conclusions cannot be drawn. S. Gamgee, who was only directly exposed to the One Ring for several hours, suffered no known ill effects. Given the evidence presented above, it is recommended that Orodruinium be classified as a hazardous material.

*Optical properties*—Among the most important of Orodruinium's characteristics is its curious optical property; namely its ability to render the wearer of the One Ring invisible. This experiment has been replicated numerous times and in various locations, for example the Gladden Fields (Isildur, 2 TA), Erebor (Smaug, 2941 TA) and Orodruin (Gamgee, 60 FA).

Once again, D. L. Sauron appears to have been exempt from this optical effect. A reason for this apparent inconsistency has thus far eluded the author. Communications with Valinor have failed to produce another Maia[4] willing to duplicate the experiment.

### 4. Conclusions:

Evidence for the existence of a new element can be found in the historical literature surrounding the Annulus Unus (One Ring). The distinguishing properties of this element have been well documented but many remain unexplained. Further field work at Orodruin is required to isolate Orodruinium from its parent lava and study its properties in a controlled environment.

*—Article submitted by Kristine Larsen on behalf of P. Legolas.*

### Footnotes

[1]The Chronology of the Westlands is used wherever relevant, with TA = Third Age and FA = Fourth Age.

[2]The taxonomical designation of Hobbits as belonging to Homo sapiens was widely studied by J. Tolkien. See for example Carpenter, 1981: 158.

[3]P. Jackson debates the 18 year timing of F. Baggins' contact with the One Ring, suggesting instead an exposure time of only 18 months.

[4]W. Gandalf, Maia mithrandir, refused an earlier offer to handle the One Ring.

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*Funding provided by the Gondorian Department of Defense.

# The Back Page

## Physicists and Traffic Flow

*By Craig Davis*

Craig Davis

Most of us have experienced the frustration of traffic congestion on urban freeways. Often, for no apparent reason, traffic will slow to a crawl or even a standstill and after several minutes return to normal speeds. Perhaps this was caused by an earlier incident, but it is seldom evident. Usually a jam will persist until traffic has thinned considerably.

Congestion costs almost 100 billion dollars annually in this country when wasted time and fuel are computed, to say nothing of the increased air pollution and accident rates. The United States is not unique in this phenomenon—most major cities worldwide experience the same problem. Further construction of freeways to alleviate congestion is unlikely in many cities. Thus it is imperative to understand traffic better and to devise methods to use existing capacity more efficiently.

One of the first physicists to study traffic flow was Robert Herman of the General Motors Research Laboratory.

In the 1960s, he and colleagues (which included Ilya Prigogine and Elliott Montroll) applied principles of statistical physics to traffic. Models they developed are still used today in some large-scale commercial simulation codes. One successful outcome of this work was the counter-intuitive suggestion to reduce congestion by installing traffic lights at the entrance to the Lincoln Tunnel.

Interest within the physics community languished until the late 1980s when several developments took place. On the empirical side, good data on traffic flow was obtained using instrumented highways, particularly in Europe.

At the same time, theoretical concepts such as self-organization and simulations based on cellular automata were applied to traffic flow. Although traffic is a dynamical system far from equilibrium, the notion of phase transitions can be used to describe abrupt changes in flow. These transitions are considered first order because hysteresis is observed.

### Jamming and synchronized flow

The simplest transition is free flow to a jam—referred to as the jamming transition. A traffic jam on a freeway (where vehicles go abruptly from highway speeds to near standstill and later return to their original velocities) is a striking example of self-organized behavior. No person or agency orchestrated this collective action. (We exclude from consideration jams formed by accidents in which the road is blocked.) When the density of vehicles is large enough (~30/km), a random event such as a fluctuation in a leading car's velocity can induce a transition from free flow to the jammed phase. As approaching vehicles slow down, the leading edge of the jam propagates upstream. The speed of propagation is ~15 km/h. The width of the jam grows because more vehicles are added to the jam than leave at the downstream boundary, which propagates at a slower pace.

Once a jam has formed, it persists until the incoming flow drops sufficiently for the width to vanish. Parameters that determine the critical density for jamming include driver reaction times (~1 second) and the mechanical time constants of vehicles.

In multi-lane highways, when traffic density is high enough, lane changing tends to equilibrate vehicle speeds across lanes. This phenomenon is called synchronization. Although synchronization of speed is obvious in the data, the significance of a transition to the synchronized flow phase has only recently been appreciated.

Apparently the sequence of transitions (a) free flow to synchronized flow and then (b) synchronized flow to a jam is more common than simply jamming.

Synchronized flow differs from jamming in several respects. First of all, the reduction in vehicle velocity is not severe. Typical speeds are in the range 20-40 km/h. Flow rates are also larger, although nowhere near the maximum capacity of ~2500 vehicles/h in each lane.

The distinguishing feature of transitions from free flow to synchronized flow is the "bottleneck." It can be as simple as a region of reduced speed (due to road construction, for example) or the termination of a lane.

Even vehicles slowing down to exit a freeway can induce synchronized flow. However, synchronized flow typically is induced by onramps. Merging vehicles disrupt the normal flow of the freeway as oncoming vehicles slow or switch lanes to accommodate them. If merging is frequent and the mainline flow is high, the average velocity of oncoming traffic drops in the neighborhood of the onramp. Just as in jamming, the region of reduced speed must propagate upstream because the incoming rate exceeds the flow in the bottleneck. (*See Figure 1.*) The downstream boundary of reduced velocity is pinned at the bottleneck. The total flow emerging from the bottleneck is limited by the capacity of the remaining freeway lanes.

Highway traffic data clearly indicate the difference between free flow and synchronized flow.

The flow rate is a product of the average velocity and the density. Since the velocity does not vary much with density up to about 20 vehicles/km, the plot of flow against density is nearly linear.

Above that density, however, the average vehicle velocity, and especially the flow rate, drops precipitously. The data no longer fall on a curve but occupy a broad region in flow-density space. (*See Figure 2.*)

### Models and simulation

There is no shortage of traffic models, although none is entirely satisfactory. A key ingredient in most models is the tendency of drivers to slow down as the density of vehicles increases. This implies that a plot of average flow rate (in the absence of transitions) versus density, the so-called fundamental diagram (*See figure 2*), increases linearly at low densities, levels off at a characteristic density of ~30 vehicles/km, and then drops to zero as the density approaches bumper-to-bumper conditions. The region of declining flow rate is associated with instability.

Boris Kerner of DaimlerChrysler AG and collaborators have proposed and championed the three-phase traffic model. The three phases are free flow, synchronized flow, and jams. The latter two phases can be further classified according to several subcategories.

Complex patterns of flow that may be a combination of phases are frequently observed. Simulations using the optimistically named "intelligent driver model" of traffic flow suggest other patterns with descriptive names such as triggered stop-and-go waves and oscillatory congested traffic.

Dirk Helbing of the Institute for Economics and Traffic in Dresden, Germany and his associates developed the intelligent driver model. The equilibrium solutions of their model fall on the fundamental diagram curve.

Kerner has challenged this result, common to a number of models. He thinks that equilibrium solutions should occupy a two-dimensional region of flow-density space, not just a curve. Perhaps the most significant consequence of the three-phase model is the questions it raises about the validity of the fundamental diagram. The traffic research community has not yet reached a consensus on this point.

The study of traffic flow and its connections to non-equilibrium statistical physics and modern concepts from complexity theory has now captured the attention of many in the physics community, and their papers in *Physical Review Letters* and *Physical Review E* are frequently referred to by prominent traffic engineers.

As gratifying as this is, it will become truly satisfying when our newfound knowledge leads to substantial improvements in traffic flow, the efficient use of freeway capacity, and reduced congestion.

How might this be accomplished? Further investigation of traffic metering, which has been in use for over three decades, might be productive. By restricting the flow of incoming vehicles from onramps, freeway congestion has been reduced but not completely eliminated. Also, traffic information provided to drivers electronically or by roadside signs can help drivers choose alternative routes and avoid troubled areas. Likewise, simulations with dynamic speed limits show promise (assuming compliance).

Some researchers suggest that adaptive cruise control can alleviate congestion. In such systems, which are just now becoming available commercially, vehicle speed is controlled by measuring the range (and its time derivative) to the preceding vehicle. Intelligent vehicle systems with dual-mode vehicles are being discussed for the longer term. Clearly there is room for innovative new ideas in traffic theory and control.

*Craig Davis is an adjunct professor in the Physics Department at the University of Michigan. He retired from the Ford Motor Company research labs two years ago.*

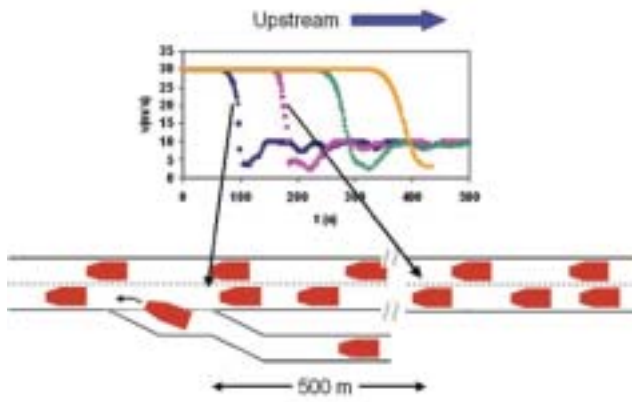


***Figure 1.*** *Vehicle velocities in synchronized flow (schematic). The blue points are for vehicles passing the onramp. The other colored points are for equal distances upstream, illustrating the propagation of the leading edge of the transition from free flow.*

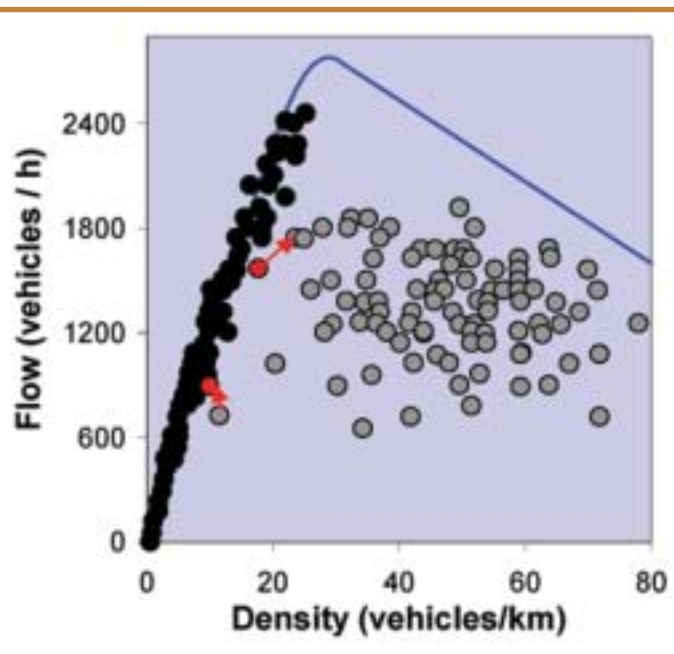


***Figure 2.*** *Schematic fundamental diagram (solid line) and measured traffic flow on a German autobahn. Vehicle flow is linear with increasing density up to a critical density of ~30 vehicles/km. Above that density, a perturbation can cause a transition to synchronized flow (upper red arrow at ~18 vehicles/km), from which the system does not recover until the density drops to a much lower value (lower red arrow at ~11 vehicles/km). (Adapted by Craig Stephan and the author from B. S. Kerner and H. Rehborn, "Experimental properties of phase transitions in traffic flow", Phys. Rev. Lett. 79, p. 4030-33, 1997.)*