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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ OCTOBER 11, 2008

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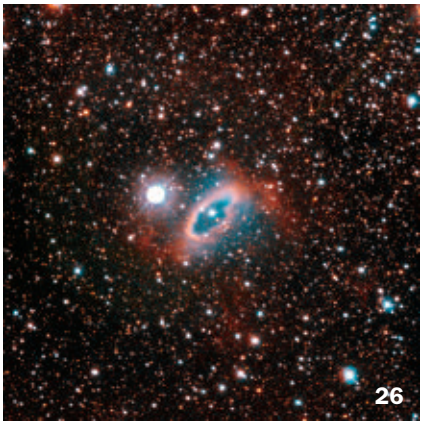
OCTOBER 11, 2008 • VOL. 174 • NO. 8



FROM TOP: WIECH *ET AL.*; KASTBERGER; ENRICO SACCHETTI; NASA, NOAO, H. BOND AND K. EXTER/STSCI; AURA

ScienceNews

In The News

Features

Departments

COVER Long English cucumber and other plants grow in the Science Barge's rooftop greenhouse, which demonstrates urban farming in action. *Enrico Sacchetti*

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Politics needs science for sound policymaking

Politics and science are a lot like oil and water. One involves machines, the other is essential for life. And they don't mix — at least not very well.

Nevertheless, politics and science should sometimes be emulsified, particularly in election years. Policies adopted in ignorance of (or with disregard for) science inevitably do damage to the public good. Decisions on serious science-related issues (stem cell research, missile defense systems, bioterrorism defense strategies) can enhance, or undermine, the nation's health and safety. Support for basic research (or lack thereof) can solidify (or destroy) the foundation for future economic growth and prosperity.

So far, scientific issues have not exactly grabbed center stage in this year's presidential election campaign. But some groups have elicited comments from the candidates (or their staffs) on some of the central scientific questions likely to face the next administration. Senior editor Janet Raloff has used these and other sources (the candidates did not respond to requests for interviews) to outline the contenders' positions on scientifically relevant issues, from energy research and global warming responses to funding for biomedical science and the future of the space program (Page 22).

For anyone who believes that science (or *Science News*) should stay out of politics, another story in this issue illustrates the urgency of connecting science to political decision making. Staff writer Rachel Ehrenberg reports (Page 14) on a new study, based on data collected by the U.S. Centers for Disease Control and Prevention, linking the chemical bisphenol A to serious human diseases. Widely used in many plastics, bisphenol A has been repeatedly identified as a potential risk (*SN: 9/29/07, p. 202; SN: 8/11/07, p. 84; SN: 1/21/06, p. 36*). Yet the U.S. Food and Drug Administration has steadfastly maintained that current exposure levels are not dangerous.

On its face, the new study seriously questions that view. Supposedly "safe" exposures are dozens of times higher than the levels of bisphenol A associated with elevated risk of heart disease, diabetes or liver problems.

It seems to some scientists (*SN: 9/13/08, p. 15*) that governments have been ignoring what researchers have been finding about bisphenol A. Without prejudging the ultimate outcome of research on this question, here's a modest hypothesis: Politics has entangled itself in the process of assessing bisphenol A's environmental and health impacts.

Let's hope the next administration will find out if that is so, and take steps to separate the scientific water from the political oil. — *Tom Siegfried, Editor in Chief*

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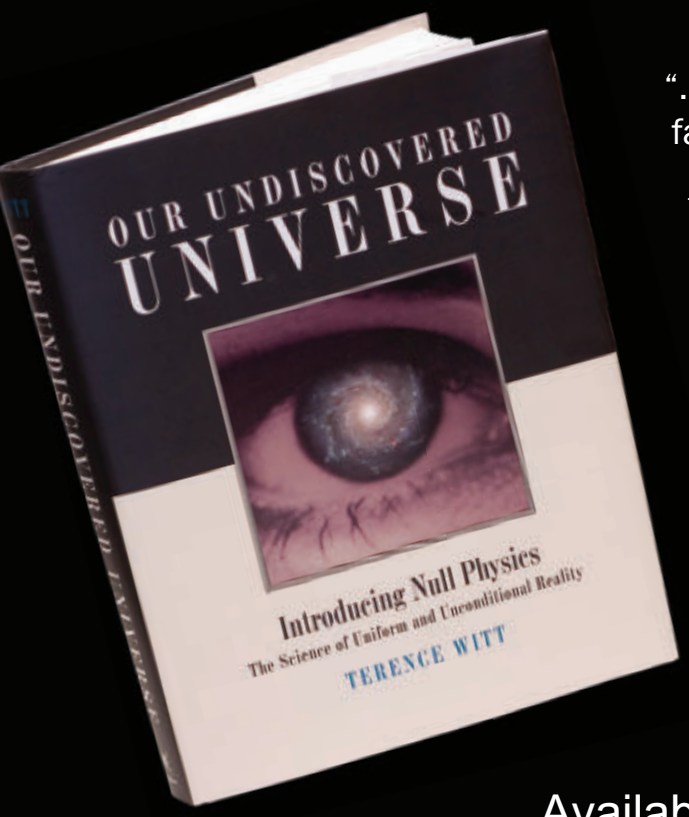

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-Dr. Hamid Rassoul, Associate Dean: College of Sciences; Founding Director of GPL; Professor: PSS, Physics and Space Science, Florida Institute of Technology

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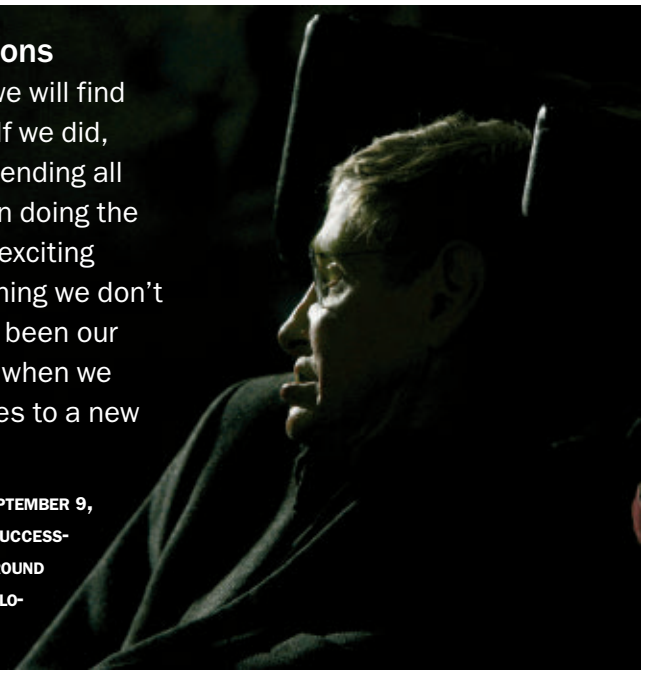
Scientific Observations



"We don't know what we will find when we run the LHC. If we did, it wouldn't be worth spending all that time and money on doing the experiment. The most exciting result would be something we don't expect. That has often been our experience in the past when we have pushed our studies to a new energy range."

STEPHEN HAWKING TOLD BBC ON SEPTEMBER 9, THE DAY BEFORE RESEARCHERS SUCCESSFULLY SENT A BEAM OF PROTONS AROUND THE LARGE HADRON COLLIDER'S 27-KILOMETER TUNNEL.

Science Past | OCTOBER 11, 1958

FISHY CONVERSATIONS — Spiny lobsters are like men, their voices become deeper as they grow older. This is one of the preliminary findings of Dr. James M. Moulton of Bowdoin College, Brunswick, Me., who spent this summer at the Bermuda Biological Station eavesdropping on the conversations of undersea life. In countless other marine biological stations and research laboratories throughout the world, other researchers like Dr. Moulton are studying the various aspects of the oceans. The aim is twofold: They hope to unravel some of the mysteries of what many scientists feel is the "last frontier," the oceans. They hope that their studies will one day provide mankind with limitless harvests that will feed an expanded population which the land will no longer be able to sustain.

Science Future

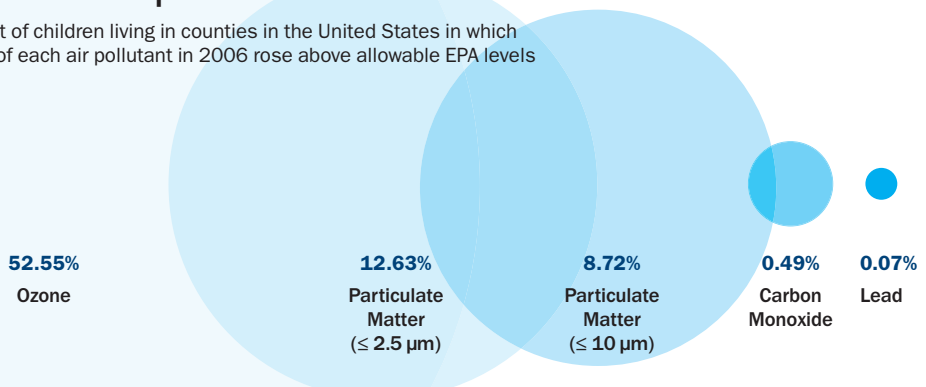
October 16–25
Imagine Science Film Festival to be held in New York City. Visit www.imaginesciencefilms.com

October 28–30
ChemEng08 to be held in Birmingham, England. Visit www.chemeng08.com

November 1
The Dibner Hall of the History of Science opens at The Huntington Library, Art Collections and Botanical Gardens in San Marino, Calif. Visit www.huntington.org

Science Stats | UNACCEPTABLE EXPOSURE

Percent of children living in counties in the United States in which levels of each air pollutant in 2006 rose above allowable EPA levels



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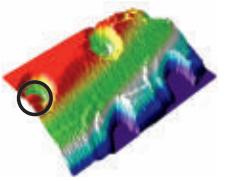

ATOM & COSMOS
As the summer wanes on Mars' northern plain, the Phoenix Lander works on. Read "Racing against the Martian winter" for an update on the robotic geologist and its findings. Pictured above is a 3-D image of a Martian dust grain (circled).

MATH TREK
The search for the largest prime number continues, with the latest behemoth weighing in at almost 13 million digits. We'd show a photo, but that would require about 30 miles of magazine type. Read "Largest known prime number found."

How Bizarre

Unlike a ball dribbled on a gym floor, a basketball that hits concrete lets out a thump and a high-pitched ring. Physicist Jonathan Katz of Washington University in St. Louis was inspired by his son to figure out why. After a few simplifications, Katz calculated that the initial hit releases a dull thud because the ball's volume changes, sending a sound wave in all directions at once. When the ball bounces back, the air in it oscillates, making the skin oscillate and creating the ring. His paper is available at arxiv.org/abs/0808.3278.

FROM LEFT: MATT DUNHAM/REUTERS/CORBIS; NASA, JPL-CALTECH, UNIV. OF ARIZONA, UNIV. OF NEUCHATEL, IMPERIAL COLLEGE LONDON

“We tend to prioritize our daytime activities, but this is one more example of how important sleep is to maintaining health.”

— MICHAEL IRWIN, PAGE 14

In the News

STORY ONE

With a twinkle, pulsating stars could deliver signals from ET

Neutrino beams may turn Cepheids into messengers

By Ron Cowen

Searching for signals from extraterrestrials can be a ticklish business. Astronomer John Learned thinks tickling certain stars in just the right way might be a good strategy for ET to phone Earth.

Those stars, known as Cepheid variables, brighten and dim on a regular schedule. In 1908, after analyzing stars on photographic plates at Harvard College Observatory, Henrietta Swan Leavitt reported that a Cepheid’s maximum brightness depends on the timing of its bright-dim cycle. The longer the period, the brighter the star. Other astronomers soon realized that they could use the period-brightness relationship to measure distances to remote galaxies.

A century later, Learned and colleagues are proposing a new use for Cepheids. In an article recently posted online (arxiv.org/abs/0809.0339), the researchers suggest that tinkering with the core of a Cepheid variable using a beam of neutrinos could be an effective way for advanced civilizations to communicate. This modulation, or “tickling,” would alter the phase at which the star brightens and slightly shorten the time it takes for the star to wax and wane, creating a new pattern that distant observers might detect.

W. FREEDMAN/OBSERVATORIES OF THE CARNEGIE INSTITUTION FOR SCIENCE, NASA, ESA

This Hubble Space Telescope image shows a Cepheid variable (circled) in the galaxy M100. These stars’ pulsations are used to measure distances to remote galaxies.

Although most SETI (search for extraterrestrial intelligence) programs use radio telescopes to look for alien broadcasts, fiddling with Cepheids has advantages for both senders and receivers, Learned and his colleagues note. Not only can the stars be seen from afar, but “Cepheids are great because any emergent civilization will surely find them and monitor them for the very same reasons we do,” says Learned, of the University of Hawaii at Manoa. And astronomers have searchable records of Cepheids that go back well over a century.

Another advantage, says Learned, is that a Cepheid star — unlike a directed radio signal — would radiate in all directions, making it more likely that the radiation would be recorded on Earth.

“If it could work, then this is an answer to one way to build an omnidirectional beacon,” says Jill Tarter, director of the Center for SETI Research in Mountain View, Calif. “It would be an example ››

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›› of an 'almost natural' signal that would get captured in a survey of the universe by an emerging technology, that's us, and finally recognized in a database by some curious grad student."

Neutrinos seem ideal for tinkering with Cepheids because these subatomic particles travel rapidly and interact with matter so weakly that they could penetrate all the way to the star's core. If delivered at just the right time during the Cepheid's cycle, when it's in its compact, dim phase, the energetic neutrinos "would change both the pulsation rate and the peak amplitude" of the star using a minimum of energy, Learned says. "We leave it as an engineering problem for the star-tickling civilization out there," to determine the optimal energy, the researchers wrote.

Detecting the pattern won't be easy. "One glitch tells us nothing," Learned says. "It will take discerning a pattern of glitches, and some regularity to find something interesting."

Although star tickling is beyond current human ability, "it's silly to try to guess whether it's feasible for some unknown, incredibly advanced civilization to be able to do this," comments Jeff Scargle of NASA's Ames Research Center in Moffett Field, Calif. "It's a really smart idea because ... the star generates the energy; all you have to do is change it a little bit. It's a nice way to piggyback on what nature has supplied."

He points out that researchers could start looking for artificially modulated signals by combing through the huge database on Cepheids amassed over decades by amateur and professional astronomers.

Neutrinos play a more direct role in another new way to look for ET. In a paper posted online in March, Zurab Silagadze of the Budker Institute of Nuclear Physics in Novosibirsk, Russia, details how neutrinos created by alien civilizations might be detected on Earth (arxiv.org/abs/0803.0409). The article is a follow-up to an idea that researchers first speculated about nearly three decades ago, Silagadze says.

Particle accelerators that collide beams of muons — heavy cousins of the electron — would produce intense neutrino beams. (Such accelerators are possible with known technology.) An advanced civilization with such a collider could communicate with other societies via neutrinos. The simplest possibility, Silagadze says, is to "periodically switch on and off the neutrino source to organize short and long signals, a kind of Morse code."

"Neutrino communication schemes are broad band, and you do not have to know the transmission frequency," he adds, allowing signals to be sent to the maximum number of unknown civilizations.

Henrietta Swan Leavitt studied Cepheids at the Harvard College Observatory in the early 1900s.

Suppose, Silagadze says, that a civilization within 20 light-years of the solar system produces 100-trillion-electron-volt beams of neutrinos directed toward Earth. He calculates that a neutrino detector called IceCube, now under construction beneath ice at the South Pole, could detect seven to 10 muons per year generated by neutrino impacts in the ice.

IceCube researcher Buford Price of the University of California, Berkeley, says that those muons, unlike random muons from space, "would all point closely in the direction of the muon collider that belongs to the advanced civilization." The signal would be easier to discern if the senders turned it on and off.

About half finished, IceCube is now taking data. Says Price: "We will let the world know if we see a beam correlated in both direction and time." ■

Back Story | SEARCHING FOR SIGNALS

1959
Philip Morrison (shown) and Giuseppe Cocconi write "Searching for Interstellar Communications," now considered a founding paper in the modern SETI field.

1960
Project Ozma, led by astronomer Frank Drake (shown), uses a radio telescope to search for ET signals from the stars Tau Ceti and Epsilon Eridani.

1993
NASA halts funding for the search for ET signals. Other projects continue the effort, including SERENDIP, a survey using the Arecibo radio telescope.

1999
SETI@home is launched. Volunteers use personal computers in screen-saver mode to analyze chunks of data for an alien signal.

2007
The first phase of the Allen Telescope Array in California is completed. Eventually it will scan a wide range of radio frequencies for ET signals.

CLOCKWISE FROM TOP LEFT: AIP EMILIO SEGRE VISUAL ARCHIVES; SETH SHOSTAK/SETI INSTITUTE; COURTESY OF THE NAIC-ARECIBO OBSERVATORY, A FACILITY OF THE NSF; NRAO/AUI; CALVIN CAMPBELL/AIP EMILIO SEGRE VISUAL ARCHIVES

AS HEARD ON PAUL HARVEY NEWS

New advanced portable heater can cut your heating bill up to 50%

Heats a large room in minutes with even heat wall to wall and floor to ceiling

Does not get hot, cannot start a fire and will not reduce humidity or oxygen

A new advanced quartz infrared portable heater, the EdenPURE™, can cut your heating bills by up to 50%.

You have probably heard about the remarkable EdenPURE™ as heard on Paul Harvey News and on television features across the nation.

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Unlike other heating sources, the EdenPURE™ cannot put poisonous carbon monoxide into a room or any type of fumes or any type of harmful radiation.

Q. What is the origin of this amazing heating element in the EdenPURE™?

A. This advanced heating element was discovered accidentally by a man named John Jones.

Q. What advantages does infrared quartz tube heating source have over other heating source products?

A. John Jones designed his heating source around the three most important consumer benefits: economy, comfort, and safety.

In the EdenPURE™ system, electricity is used to generate infrared light which, in turn, creates a very safe heat.

After a great deal of research and development, very efficient infrared heat chambers were developed that utilize three unique patented solid copper heat exchangers in one EdenPURE™ heater.

Q. How can a person cut their heating bill by up to 50% with the EdenPURE™?

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End of interview.

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Readers who wish can obtain the EdenPURE™ Quartz Infrared Portable Heater at a $75 discount if they order in the next 10 days. Please see the Special Reader's Discount Coupon on this page. For those readers ordering after 10 days from the date of this publication, we reserve the right to either accept or reject order requests at the discounted price.

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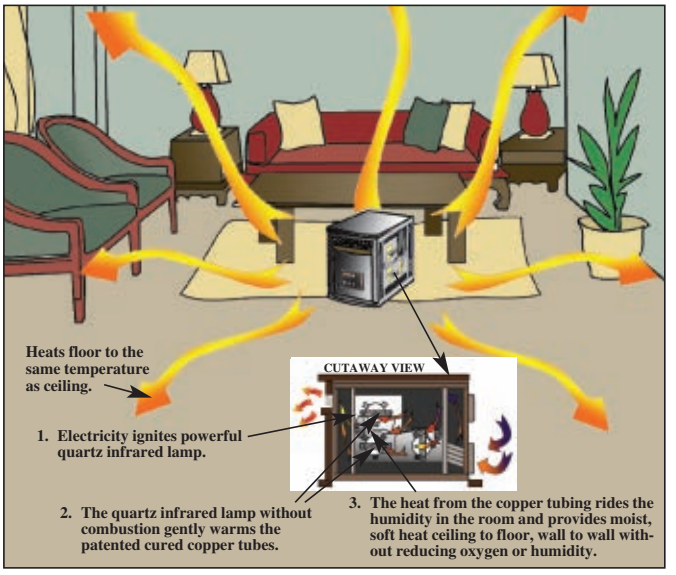

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Astronomers snap extrasolar image

Shot may be the first of an exoplanet orbiting a sunlike star

By Ron Cowen

After years of false alarms, astronomers may finally have recorded the first image of a planet orbiting a sunlike star beyond the solar system.

The body, about eight times Jupiter's mass, lies exceptionally far from its presumed parent star — roughly 11 times Neptune's average distance from the sun.

"If this object is a planet at such a wide separation, it would challenge our conceptions of planet and companion formation," says Adam Burrows of Princeton University.

In an article posted online September 10 at arxiv.org/abs/0809.1424, codiscoverers David Lafrenière, Ray Jayawardhana and Marten H. van Kerkwijk of the University of Toronto caution that there's a chance that the object merely resides in the same part of the sky as the star but is not gravitationally bound to it.

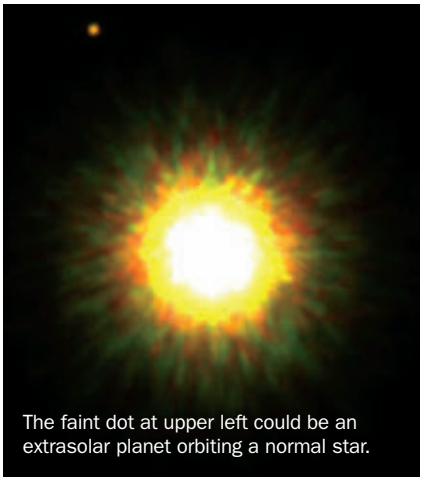
But if the body does orbit the young sunlike star, which has the unwieldy name 1RXS J160929.1-210524, it could pose a problem for planet formation theories. A widely accepted model suggests that the planet-forming disks of gas, dust and ice surrounding newborn stars concentrate material close to their stars.

"The bulk of the material from which planets might form is significantly closer to the parent star," Burrows says.

The outermost parts of such disks wouldn't contain enough material to assemble a Jupiter-mass planet at the distance from the star — 330 astronomical units, or 330 times the separation between Earth and the sun — at which the team found the faint object.

"At hundreds of astronomical units from the star, the density of material in the disk is so low that any small seed of planet would not be able to grow [large] enough before the disk vanishes in a few million years," Lafrenière says.

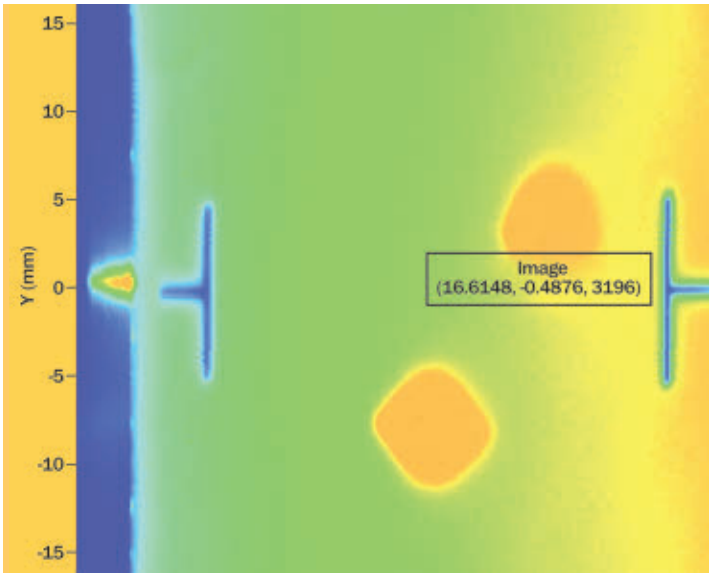
He and his colleagues found the object by using a special optics system on the Gemini North telescope atop Hawaii's Mauna Kea. They scoured the vicinity of some 85 stars belonging to the Upper Scorpius association. Stars in this group lie 500 light-years from Earth and are only about 5 million years old. The sun is 4.56 billion years old.



The faint dot at upper left could be an extrasolar planet orbiting a normal star.

Most of the more than 300 extrasolar planets astronomers have discovered since 1995 have been detected indirectly. Though researchers imaged an exoplanet around a brown dwarf in 2004, no one has recorded an image of a planet orbiting a sunlike star.

Astronomers will need to track the motion of the newly discovered body across the sky for one to two years to determine whether it moves in sync with the star, Jayawardhana says.



Around the ring

One short trip for a proton, one not-so-giant step for mankind, it turns out. On September 10 scientists at the Large Hadron Collider, near Geneva, successfully steered the first beam of protons around the accelerator's 27-kilometer circular track. After entering the tunnel, the beam twice struck a scintillating screen, causing atoms in the screen to emit light. The first yellow spot in the screen grab at left was created just after the protons were kicked onto the correct trajectory by the injection system. The second spot was generated after the protons made one complete revolution, again striking the screen. But just nine days after this initial success, a faulty electrical connection in the tunnel led to a helium leak. Officials say the setback, combined with the closing of the accelerator during the winter to save fuel costs, means the long-awaited collision won't be attempted until at least next spring. —*Ron Cowen*

FROM TOP: LAFRENIÈRE *ET AL.*, GEMINI NORTH; CERN

Humans

For longer versions of these and other Humans stories, visit **www.sciencenews.org**

Mom can increase her child's risk of depression via nurture alone

New study suggests fathers don't have the same influence

By Bruce Bower

Some youngsters get depressed in the absence of any genetic legacy, a new investigation finds.

Researchers report that having a depressed mother substantially ups a teenager's likelihood of becoming depressed, even if he or she was adopted and shares no genes with the mother.

This finding provides the first direct evidence that purely environmental factors can promote depression in the children of depressed women, says a team led by psychologist Erin Tully of the University of Minnesota in Minneapolis.

A depressed father does not increase the risk of depression in adopted or non-adopted teens, the team reports in the September *American Journal of Psychiatry*.

Two other investigations, both published in the same journal, further emphasize nurture's role in depression, showing that successful treatment of depressed mothers spurs emotional gains in their depressed children.

"There is an environmental liability of maternal depression that cannot be accounted for by genes but that almost certainly interacts with genetic factors to create depression risk in children," Tully says.

Depression can impair a mother's parenting skills, cause marital conflict and disrupt a youngster's ties to peers and school — and these outcomes can in turn spread depression from mother to child, she suggests.

A growing number of studies demonstrate difficulties that depressed mothers have in interacting with their children, remarks psychiatrist John Markowitz of Columbia University. Tully's study "bolsters the evidence that maternal, more than paternal, depression meaningfully affects children through home life, not just heritability," he says.

Tully and her coworkers studied 568 adopted adolescents, most from Asian countries, 416 non-adopted adolescents and one or both parents of all the children. Nearly all parents and non-adopted kids were white, and all the families lived in Minnesota. Most adoptions occurred before age 1.

Psychiatric interviews with the parents and teenagers probed for current and past symptoms of major depression and other psychological conditions.

While living with a depressed mother boosted the mood disorder's prevalence in adopted teens, non-adopted teens with depressed mothers were even more likely to become depressed. Having a depressed mother also increased the rate of behavior problems in both groups.

Pain relief you can believe in

Study finds religious thought alleviates hurt for Catholics

By Bruce Bower

Brain researchers are exploring what might be called faith-based analgesia.

Stimulating a religious state of mind in devout Catholics triggers brain processes associated with substantial relief from physical pain, report neuroscientist Katja Wiech of the University of Oxford in England and her colleagues online September 5 in *Pain*.

"Our data suggest that religious belief alters the brain in a way that changes how a person responds to pain," says study coauthor Irene Tracey, also of Oxford.

Practicing Catholics perceived electrical pulses as less painful while viewing an image of the Virgin Mary than while viewing a non-religious picture. Functional MRI showed a change in these volunteers' brain activity only while looking at the religious icon.

In contrast, professed atheists and agnostics derived no pain relief from viewing the same religious image while getting uncomfortably zapped on the hand.

"What's exciting is that this new study shows a neural mechanism by which religious belief affects pain perception," remarks psychiatrist Harold Koenig of Duke University in Durham, N.C.

In alternating trials, 12 Catholics and 12 atheists or agnostics spent 30 seconds observing an image either of a painting of the Virgin Mary or of *Lady with an Ermine*, by Leonardo da Vinci. The images remained visible as participants received 20 brief electrical pulses delivered to the back of the left hand.

Researchers measured pain perception while people viewed a Virgin Mary image (right) or *Lady with an Ermine* (left).

WIECH *ET AL.*

Pain relief for Catholics was accompanied by vigorous activity in the right ventrolateral prefrontal cortex, which has been linked to pain relief associated with emotional detachment and perceived control over pain. This response was not observed in non-religious volunteers.

Religious belief represents one of many ways to reappraise the meaning of pain, says Tor Wager of Columbia University. Evidence suggests placebo treatments can activate the same brain region.

Life

To watch a video of the honeybee wave, visit **www.sciencenews.org**

Giant honeybees skilled at the wave

Attacking hornets repelled when colony shimmers en masse

By Susan Milius

Like fans in a stadium, giant honeybees at their nest make big, rippling audience waves, new video shows.

And the bee waves are spooky enough to drive away predatory hornets, an international research team reports online September 10 in *PLoS ONE*.

Giant honeybees (*Apis dorsata*), unlike western honeybees, form open nests without outer coverings. Thousands of the giant bees cling to each other, sometimes seven layers deep, in a mass around the home comb, says Gerald Kastberger of the University of Graz in Austria.

Wave patterns swirl across the outer layer of this mass as a sequence of bees tip their long abdomens up and down. Kastberger and colleagues filmed and analyzed some 450 bee waves, called shimmering, in two colonies in Nepal.

Moving bee patterns, Kastberger says, offer a way to study the problem of self-organization. "It's a question of organization of a team without a chief," he says.

Giant honeybees mass around a central comb, as Gerald Kastberger observes.

Smaller waves of a few bees break out as nest mates arrive and take off. When bee-hunting hornets buzz in, however, bees wave big — 70 bees can flip into action in 600 milliseconds, and hundreds more join in as the pattern swirls over the nest.

As these big hornets, which hunt adult bees as food, dive toward a massive bee nest, the hornets "probably think it is a very nice supermarket where they can get everything without paying," Kastberger says.

But ripples of bee rears can change a hornet's direction. At closer than 52 centimeters, the hunter veers away as the audience waves. The bees' sudden motion may startle the predator, but whatever the mechanism, it works, Kastberger says. Waving maintains a rough no-hornet zone around the colony.

The new data support what observers have guessed, says Michael Breed of the University of Colorado at Boulder, who studies social insects. "To anybody who sits and watches these bees for any length of time, it's clear the shimmering is happening when there's a hornet around."

"I have seen the same thing in *Apis cerana* [a smaller bee species] in Japan," says Randall Hepburn of Rhodes University in Grahamstown, South Africa.

Besides the new paper's descriptions of predator-prey dynamics, Breed welcomes details on bee wave-making. "One of the intriguing things," he says, "is that it's really pretty." ■

Female frogs play the field

Multiple partners improve odds of offspring survival

By Rachel Ehrenberg

The danger of putting all your eggs in one basket is very real for a small Australian frog.

A new study has found that female *Pseudophryne bibronii* frogs lay eggs fathered by up to eight different males in up to eight different nests. The mothers aren't being risqué — the extreme behavior actually reduces the risk of offspring death, a team reports in the *Proceedings of the Royal Society B*.

While polyandry — one female mating with multiple males — is common among animals, eight partners in a row is a record for vertebrates, says Phillip Byrne of Monash University in Melbourne, Australia, who led the new study. Such dalliances might be widespread in unpredictable environments or in mating systems where the male is in charge of the nest, the research suggests.

Male *P. bibronii* frogs make nests in little soil depressions along small waterways that come and go with the rains. Responding to calls from males, females come to mate and lay eggs, but dads stay with the nest and developing young. Nurseries must stay wet enough that eggs don't dry out and must flood early enough for tadpoles to have time to become full-grown frogs (but not too early or the eggs get washed away). Because the mom can't really predict which nests are best — it largely depends on when and how much it rains — there is always a high risk that her whole brood will be killed.

Led by Byrne, researchers staked out nests in Australia's Jervis Bay National Park, collected fertilized eggs and reared the froglets. Genetic analyses revealed that, on average, females divided their eggs among the nests of five males. If a female visited more nests, then more of her offspring survived.

That direct link is surprising, comments Malte Andersson of the University of Gothenburg in Sweden. The usual reasons invoked for multiple mates are the odds of mating with a lousy dad or a dad with inferior genes, rather than protection against nest failure.

KASTBERGER

20 micrometers | Diameter of a mosquito's fascicle

2,000 micrometers | Length of a mosquito's fascicle

Researchers dig new ant species

Bizarre insect suggests ancient underground world

By Susan Milius

A new ant discovered in the Amazon looks so odd that scientists are choosing Latin names that playfully suggest the creature comes from Mars.

Yet the species *Martialis heureka* could help rewrite the history of ants on Earth.

Found in Brazil, the ant has a pale body and no eyes, says Christian Rabeling of the University of Texas at Austin. Its mouthparts stick out like sharp forceps and are longer than the rest of its head.

Its DNA may be even more interesting. Genetic analysis puts the new ant so far from other species that it deserves its own subfamily, Martialinae, Rabeling and his colleagues report online September 15 in the *Proceedings of the National Academy of Sciences*. It's the first new subfamily described for a living ant since 1923, the discoverers say.

"It's an incredibly bizarre-looking ant morphologically, which for ant biologists is really exciting," said Corrie Moreau, after seeing a picture. An ant specialist at the Field Museum in Chicago, she says she can think of a few other species with each of the new ant's peculiar features. But to find those rare traits combined in one species is unique, she says.

DNA analysis suggests that the odd species comes from the earliest branch of the ant family tree that still has living members, Rabeling says.

This newly discovered ant, with mouthparts like forceps and no eyes, lives underground in the Amazon.

That suggestion fits with a puzzling twist on ant history that has emerged from recent studies using DNA similarities to construct family trees.

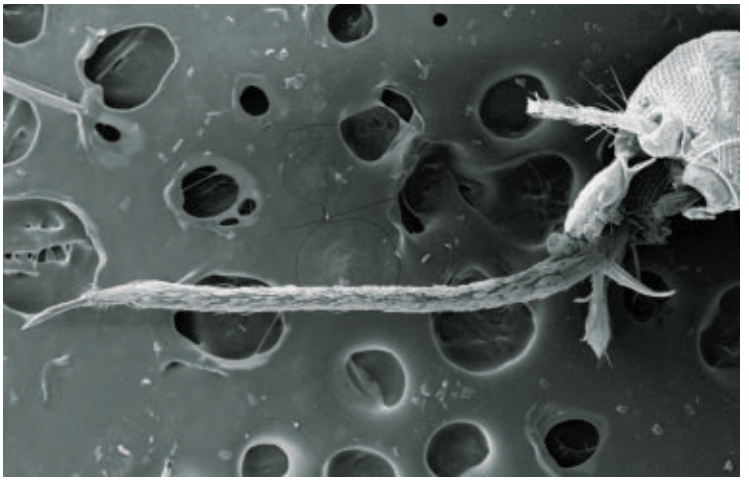
"Ants evolved from wasps — everybody agrees on that," Moreau says. However, DNA-based family trees, including one she worked on, looked as if other specialized underground ants were the most ancient living lineage.

The new species could easily be another subterranean ant, Moreau speculates, since it has no eyes, a bleached color and extreme mouthparts. Adding it to the family tree strengthens the evidence that some of today's underground ants really do come from ancient lineages.

Just how those lineages went underground isn't clear, Moreau says. Perhaps the first ants really were subterranean specialists. Or perhaps ants first evolved above ground, but the only surviving descendants of those early ancestors come from lineages that literally went under.

Rabeling happened upon the new species while rummaging in forest leaf litter at dusk. A coauthor had collected two earlier samples but lost them in a storage mishap. The researchers have called for more searches.

Naming a species based on a single specimen doesn't strike Moreau as odd, she says. "The fact that a single ant 'rediscovered' in the rainforests of Brazil can tell us so much about the evolution of the ants highlights how little we know about the diversity of life on the planet," she adds. ■



FROM TOP: C. RABELING, M. VERHAAGH; RAMASUBRAMANIAN *ET AL.*, *BIOINSPIRATION & BIOMIMETICS*

This bite won't hurt

By dissecting the physics of mosquito bites, researchers have uncovered some of the bugs' stealthy tricks. Melur Ramasubramanian of North Carolina State University in Raleigh and his colleagues wondered how a mosquito's fascicle, the needle in its proboscis, can enter the skin without buckling—despite being so thin and not so stiff. A sheath, called the labium, that normally wraps around the needle increases its stiffness by a factor of five, preventing it from buckling, the team reports in the December 2008 *Bioinspiration & Biomimetics*. As the fascicle enters the skin, the labium pulls back. The technique could provide inspiration for needles that hurt less. —*Davide Castelvecchi*

Earth

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Continental clash cooled climate

When India and Asia collided, sources of CO_2 disappeared

By Sid Perkins

When the tectonic plate carrying India slammed into Asia about 50 million years ago, the ensuing geological changes triggered a long-term cooling trend — a trend that later enabled Antarctic ice sheets to grow, a new study suggests.

Before the collision, volcanoes along the rim of southern Asia spewed immense quantities of carbon dioxide into the atmosphere. Much of that planet-warming greenhouse gas came from seafloor, carbonate-rich sediments that were being shoved below Asia by tectonic movements, says Dennis V. Kent, an earth scientist at Rutgers University in Piscataway, N.J.

When the collision shut down some geological processes, the climate ended up in the icehouse.

The tectonic plate that carried what is now the Indian subcontinent split from Gondwana, the supercontinent that sat astride the South Pole, about 120 million years ago. The subcontinent began to move quickly northward, at times migrating 25 centimeters per year, Kent says.

Before India reached the tropics, a spate of volcanic activity lasting a million years spewed about 4 million cubic kilometers of basalt lava — an outpouring that contributed to the demise of the dinosaurs, some scientists propose.

By about 50 million years ago, when India crashed into Asia, atmospheric CO_2 levels sat well above 1,000 parts per million. But after the collision, seafloor sediments were no longer a volcanic source of CO_2, so levels began to drop, Kent and his colleagues argue in a paper published online September 22 in the *Proceedings of the National Academy of Sciences*.

Simultaneously, erosion of rocks on the Indian subcontinent — in particular, the chemical weathering of a large amount of basaltic rocks formed from volcanic eruptions just a few million years earlier — consumed large volumes of CO_2.

When the volcanic basalts formed, only 3 percent of Earth's continental land area sat within 10 degrees of the equator. But as tectonic motions carried India into the tropics and shifted other land masses, that proportion increased to about 20 percent. The high temperature and rainfall of the tropics increased erosion on the landmass, essentially soaking up large amounts of CO_2 from the atmosphere.

This double whammy, the researchers speculate, caused atmospheric concentrations of CO_2 to plummet, cooling Earth significantly.

Between 50 million and 34 million years ago, as erosion and other geological processes sapped the greenhouse gas from the atmosphere, CO_2 levels dropped close to modern-day, preindustrial levels of about 300 parts per million.

Other changes in landmass distribution in the Southern Hemisphere resulted in changes in ocean currents in the region, which led to further cooling and the development of permanent ice sheets on Antarctica.

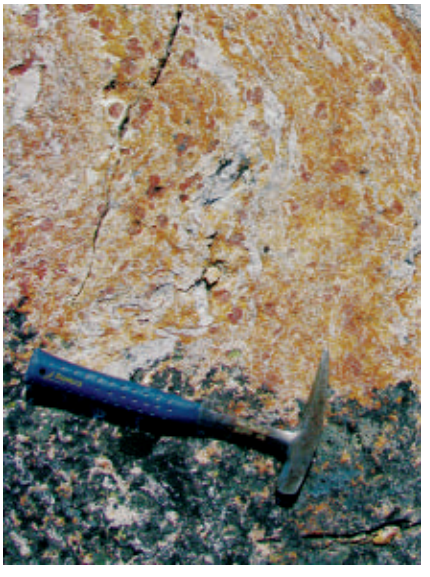
The new analyses "describe a perfect storm of carbon cycling," says Mimi Katz, a paleooceanographer at Rensselaer Polytechnic Institute in Troy, N.Y.

Pre-collision volcanism and other geological events contributed to the warmest climates of the 65 million years before today. But, she notes, when the India-Asia collision shut those processes down, the climate ended up in the icehouse.

"This is a very interesting and imaginative paper," says Karl Turekian, a geochemist at Yale University.

He notes, however, that high CO_2 concentrations and temperatures worldwide 50 million years ago ensured extensive erosion of continental rock everywhere, not just in India, casting some doubt on Kent's estimate of India's importance in the cooling.

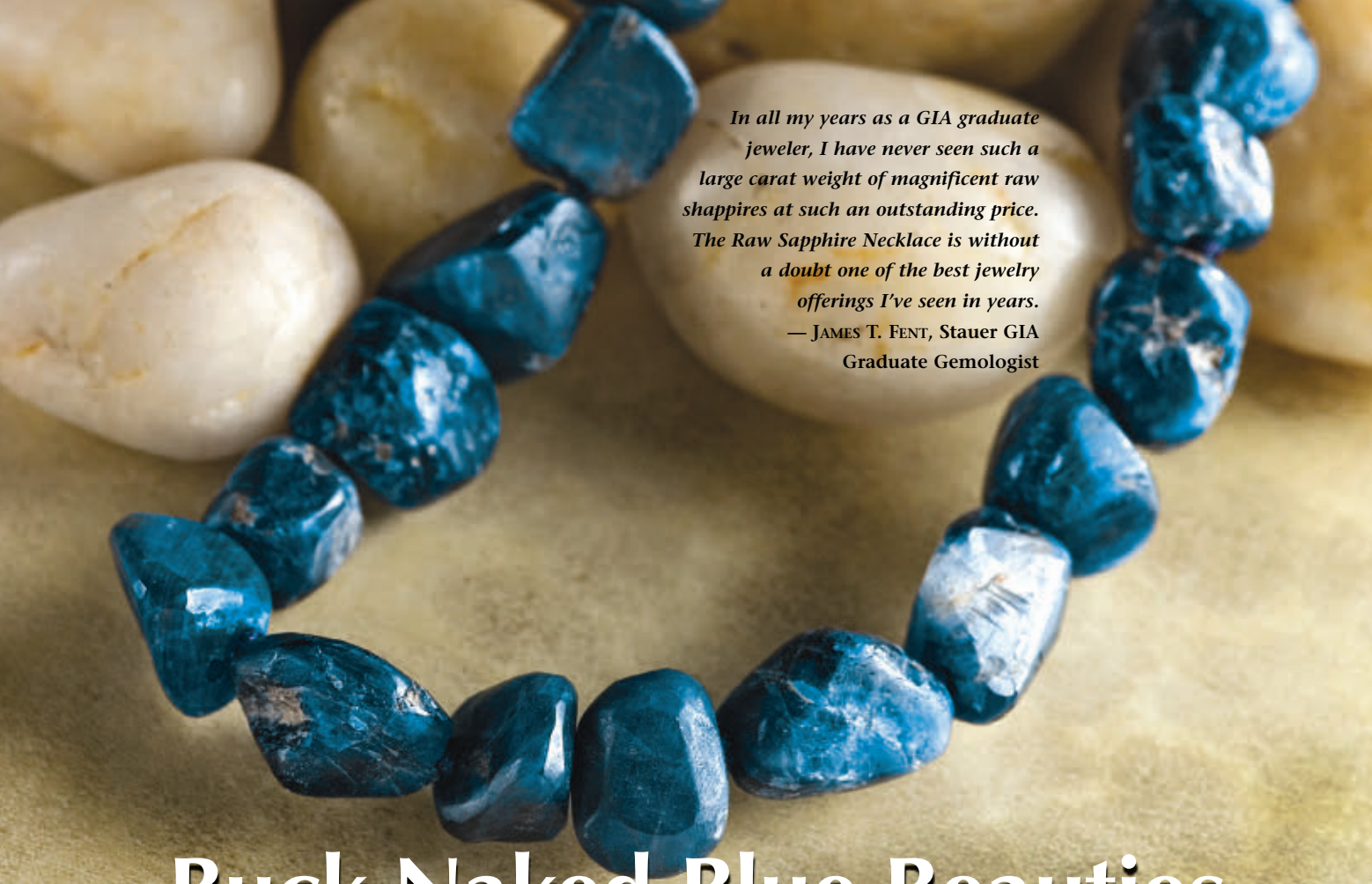
William F. Ruddiman of the University of Virginia in Charlottesville agrees that the relative contributions of all of these carbon-dioxide–sopping processes have yet to be determined. ■



SCIENCE/AAAS

Aged crust

Northern Quebec may host the world's oldest rocks. Geochemical analyses reported in the Sept. 26 *Science* hint that some rocks (shown here with a hammer for scale) along the eastern shores of Hudson Bay are 4.28 billion years old. Previous studies have suggested that tiny crystals called zircons in some sedimentary rocks in Western Australia first solidified — in rocks that have long since eroded — about 4.4 billion years ago. But the Canadian rocks, which have been heated and squeezed deep in the Earth, may be the world's oldest intact rocks, Jonathan O'Neil of McGill University in Montreal and his colleagues speculate. —*Sid Perkins*



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— James T. Fent, Stauer GIA Graduate Gemologist

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For centuries, blue sapphire has been known as the stone of destiny and desire. History's most powerful men have used the gem to woo the world's most desirable women. From King Solomon and Queen of Sheba to Napoleon and Josephine, the seductive powers of sapphire are legendary. Today, the presentation of large blue sapphires is still a grand romantic gesture. Each rare gem pulses with the passion of the ages. But it is most likely that few of these great romances have been privy to anything like a stunning 350 carat necklace of midnight ocean blue sapphires.

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Late nights tied to inflammation

Key protein spikes in women with mild sleep deprivation

By Tina Hesman Saey

Staying up late makes for a swell time, but not in a good way.

A study in the Sept. 15 *Biological Psychiatry* offers more evidence that lack of sleep is linked to inflammation, which can lead to disease. After one night of too little sleep, women volunteers had higher levels of a chemical that triggers inflammation.

Previous research with animals has shown that staying up all night can trigger stress reactions, including elevating some markers of inflammation. But people usually experience milder sleep deprivation, missing only a few hours each night.

The increase in markers of inflammation after mild sleep deprivation shows how stressful common sleep loss is, comments Amita Sehgal of the University of Pennsylvania in Philadelphia.

"The fact that this happens in a scenario that more commonly is experienced by people indicates that this is more of a health concern than previously thought," Sehgal says.

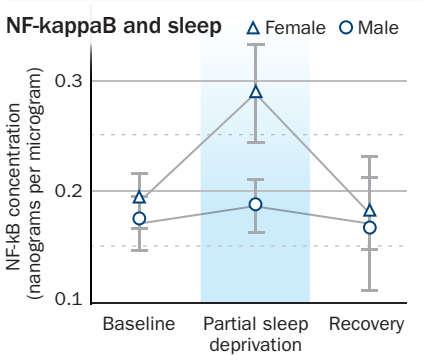
Michael Irwin of the University of California, Los Angeles and colleagues tested levels of a protein called NF-kappaB in the blood of 14 healthy volunteers, seven men and seven women. The protein is a key regulator of inflammation, and its activity has been linked to diabetes, heart disease and cancer.

The volunteers normally slept from, on average, 10:30 p.m. until 7:30 a.m. The researchers drew blood from the volunteers in the morning after a normal night of sleep, after a night in which the volunteers stayed awake until 3:00 a.m. and again after a night of recovery sleep.

One late night was all it took to cause a spike of the inflammation-promoting protein in women, the researchers found. The levels dropped to normal after the night of recovery sleep.

Men in the study didn't show any difference in the levels of NF-kappaB in their blood after missing some shut-eye. But Irwin cautions against making too much of the gender differences until larger studies can confirm the results. Women do have a greater risk of developing sleep and inflammatory disorders as they age, but men also suffer from these illnesses.

"The findings really stress the importance of a good night's sleep," Irwin says. "We tend to prioritize our daytime activities, but this is one more example of how important sleep is to maintaining health." ■



Levels of NF-kappaB in white blood cells spiked in women who missed some sleep.

IRWIN *ET AL., BIOLOGICAL PSYCHIATRY*

Plastics chemical takes another hit

For the first time, study links bisphenol A to heart disease

By Rachel Ehrenberg

A new study has linked the plastics chemical bisphenol A to heart disease. Based on a sample of 1,455 U.S. adults, the study also adds to evidence linking BPA to liver enzyme problems and type 2 diabetes.

While the liver and diabetes links are in line with animal studies, the connection to heart disease is new, says study leader David Melzer, an epidemiologist at the University of Exeter in England.

"The good news is these are man-made exposures," says Richard Stahlhut, an environmental health fellow at the University of Rochester in New York. "If the findings hold up, we could get rid of BPA and hopefully people get better. The bad news is it would mean that our system by which we determine risk is really flawed."

BPA is found in plastics used in baby bottles and aluminum can linings. In August the Food and Drug Administration issued a draft assessment decreeing that BPA is safe at current exposure levels.

The new study, published in the Sept. 17 *Journal of the American Medical Association*, is based on the National Health and Nutrition Examination Survey. That survey, NHANES, uses physical examinations, clinical tests and personal interviews to gauge the health of the U.S. population. The recently released 2003–04 NHANES provided the first large data set on BPA levels in human urine.

People with the highest urine levels of BPA (in the top one-fourth of the study population) were more than twice as likely to have diabetes or heart disease as those with lower levels. Researchers estimate that participants in the high BPA group were probably exposed to an average of 50 micrograms a day, far below levels currently considered to be safe.

Studies on animals have linked bisphenol A, which mimics the hormone estrogen, to liver damage, obesity and reproductive problems.

"The FDA is now looking, and they have decided BPA is not a problem, in spite of the evidence for harm gathered in animal studies," says Ana M. Soto of Tufts University School of Medicine in Boston. "I think this paper argues otherwise."

Lipid serves as healthy hormone

Mice benefit from fatty acid

By Tina Hesman Saey

Some fats are just better than others. Omega-3 fatty acids, including fats that make up fish oil, have been recognized for their health-promoting benefits.

Well, move over, omega-3s; now there's a fat that's even phatter. Researchers at Harvard University and Lipomics Technologies in West Sacramento, Calif., have discovered that a fatty acid, a type of lipid, can make mice super healthy.

An omega-7 fatty acid called C16:1n7-palmitoleate works as a health-promoting hormone, the researchers report September 19 in *Cell*. Palmitoleate is made by fat and liver cells, the team discovered. The fatty acid signals muscles to respond to insulin, prevents the buildup of fats in the liver and reduces levels of inflammatory chemicals made in fat cells.

The new study "really suggests that lipids — fatty acids — could have a signaling effect," says Clay Semenkovich of Washington University in St. Louis. "This is something people have postulated for a while, but has been difficult to get a handle on."

Palmitoleate is the first lipid demonstrated to work as a hormone, a job usually done by proteins, such as insulin, or by small molecules, such as adrenaline. If the lipid works the same way in people as in mice, it could someday be added to foods or given as a supplement to ward off heart disease and diabetes.

Researchers led by geneticist Gökhan Hotamisligil of Harvard had previously created extraordinarily healthy mice by preventing the mice from making two proteins that normally bind to fatty acids. Previous research had shown that blocking the proteins could improve health. But mice lacking both proteins had health "beyond the normal range," Hotamisligil says. "Almost indestructible. No heart disease, fatty liver disease, diabetes. No asthma, nothing." And their health held up even when they ate a high-fat diet.

But it wasn't obvious why the mice were so healthy. "The general dogma in the field is the more fatty acids you have in the blood, the sicker you are," Hotamisligil says. But the mutant mice had slightly higher levels of fatty acids in their blood than normal mice.

When examining which fats were present in the über-healthy mice, the scientists found that palmitoleate, normally rare, was the third most abundant fatty acid in the healthy mice's blood. The lipid improves muscle responses to insulin and prevents liver cells from accumulating other harmful fats, the researchers found. Because the mice were missing the two proteins, their fat cells were not able to store fat. The fat cells instead made lipids, primarily palmitoleate.

> "A caveman chasing a deer probably had active production of this [lipid], but not us constantly stuffing ourselves with calories."
> GÖKHAN HOTAMISLIGIL

Liver cells also make the lipid hormone, the team found. In normal mice, the lipid is produced at low levels. When these mice eat a high-fat diet, their cells cut palmitoleate production in half. But the super-healthy mice continue making lots of the lipid, even when they eat diets rich in fat.

People probably also respond to high-fat diets by producing less palmitoleate, Hotamisligil says. "A caveman chasing a deer probably had active production of this material, but not us constantly stuffing ourselves with calories."

Rather than supplementing the diet, Hotamisligil thinks it would be healthier to persuade people's fat cells to produce more of the lipid. "What you make yourself is always the best," he says. "It's like homemade cooking."

News Briefs

Highly wired

Men are dense — in the temporal neocortex anyway. An investigation of brain tissue recovered from epilepsy patients during surgery showed men had a higher density of brain cell connectors, called synapses, than their female counterparts. The finding might explain why men have better spatial perception, while women can talk faster and better remember what they hear, Javier DeFelipe of the Cajal Institute in Madrid, Spain, and his colleagues suggest online September 8 in the *Proceedings of the National Academy of Sciences*. —*Ashley Yeager*

Location, location, location

Talk about a mixed blessing. Two new studies in the Sept. 17 *Journal of Neuroscience* show that immune cells known as macrophages can do an injured neuron good or can impart further harm, depending where on the neuron's brain-to-organ path the injury is located. If the wound is in the brain or spinal cord, macrophages can prevent regeneration. But if the injury is in other parts of the body, macrophages help heal the hurt. —*Tina Hesman Saey*

Low-cal bones

Cutting way back on calorie intake for a short time doesn't take a bite out of bones in volunteers who haven't yet reached middle age, a new study shows. The finding, reported in the Sept. 22 *Archives of Internal Medicine,* thickens the debate over calorie restriction. Leanne Redman of Louisiana State University in Baton Rouge and colleagues focused on bone density as measured by X-rays before volunteers began dieting and again six months later. —*Nathan Seppa*

Let's get vertical

City buildings offer opportunities for farms to grow up instead of out

By Rachel Ehrenberg

Locally grown food is often touted as a perk of rural living. But if Dickson Despommier has anything to say about it, city dwellers will soon have the same environmental bragging rights.

Despommier wants cities to grow their own food. Not in rooftop gardens or neighborhood plots, but in light-filled buildings of glass and steel; tilapia on the first floor, tomatoes on the 12th.

It's called vertical farming, baby, and it may be coming to a skyscraper near you.

The idea is bold, but Despommier makes a compelling case. Across a scattering of labs and disciplines, researchers are refining the technologies needed for the 21st century's Hanging Gardens of Babylon. Energy efficiency and environmental impact are no longer concerns of the fringe. Increasingly, architects and city planners are looking to incorporate nature, rather than exclude it.

Some say the science for successful urban farming is already here. For years, NASA researchers have been exploring

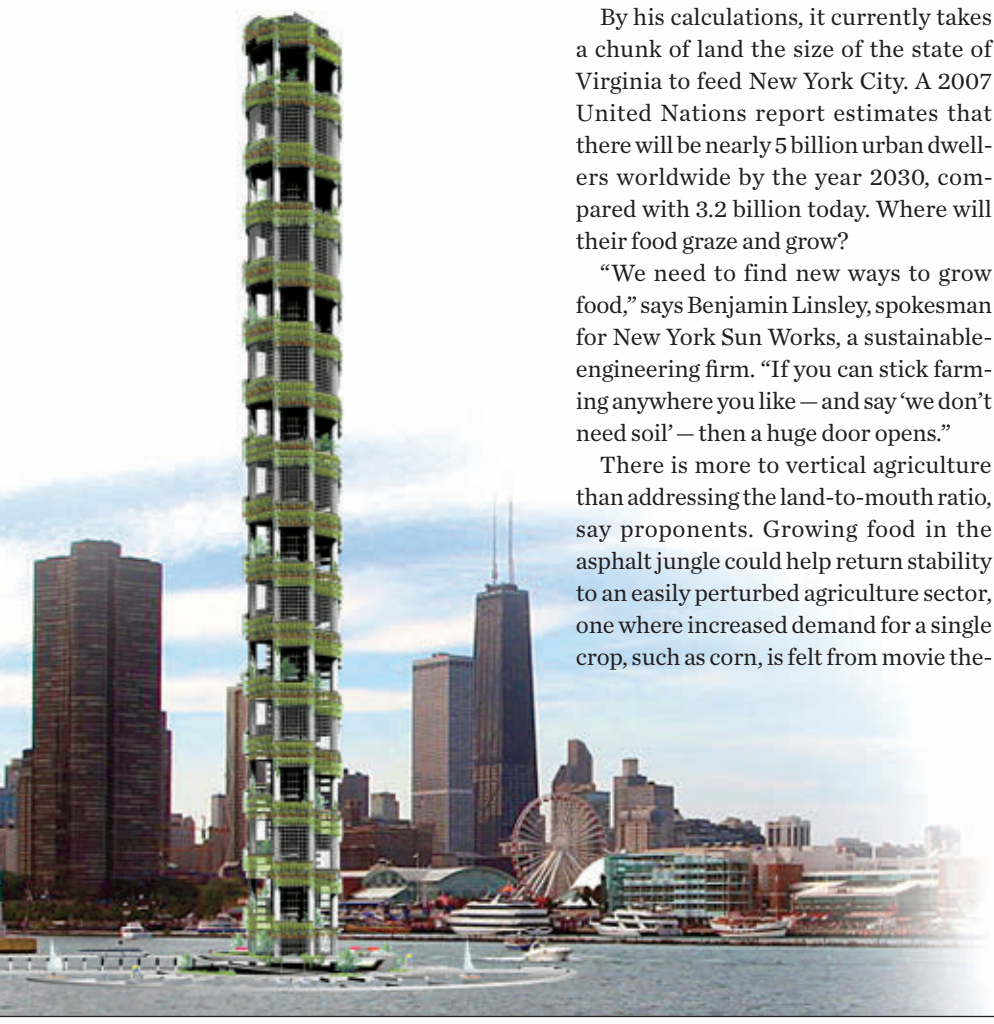
ENRICO SACCHETTI

The Science Barge, a prototype of urban farming in New York City, is decked out with solar panels, windmills and a biofuels-fed generator. Tomatoes, strawberries and other crops thrive in the barge's greenhouses.

methods for growing plants on Mars, making midtown Manhattan seem not so far-fetched. Systems for growing plants without soil — hydroponics — are already in wide use. More recent are major developments in efficient artificial lighting and climate control technologies.

The benefits of urban farming range from meeting a concrete need to feed the Earth's growing population to more nebulous perks, such as reducing wars fought over natural resources, advocates say. And the hurdles are like those that impede large-scale change wherever practices and policies are firmly entrenched — even if those practices and policies are inefficient and outdated.

Skeptics argue that the costs will always outweigh the benefits, so efforts should focus on improving efficiency in current production systems.



Vertical farming won't get a free pass, says Gary Lawrence, a former planning director for the city of Seattle who is now with Arup, a London-based engineering and design firm. (Arup's green projects include the "living roof" on the new California Academy of Sciences building in San Francisco and Dongtan, the eco-city planned for an island off Shanghai, China.) "There's a huge amount of research going on, but we need to get the costs down," he says.

Reducing carbon dioxide emissions from food transport, using biofuels or generating methane from compost have to make good business sense, Lawrence says. Ultimately, "the choice to act is a policy and financial issue."

Purely as a numbers game, vertical farming makes sense, says Despommier, who makes his academic home in the environmental health sciences department at Columbia University.

By his calculations, it currently takes a chunk of land the size of the state of Virginia to feed New York City. A 2007 United Nations report estimates that there will be nearly 5 billion urban dwellers worldwide by the year 2030, compared with 3.2 billion today. Where will their food graze and grow?

"We need to find new ways to grow food," says Benjamin Linsley, spokesman for New York Sun Works, a sustainable-engineering firm. "If you can stick farming anywhere you like — and say 'we don't need soil' — then a huge door opens."

There is more to vertical agriculture than addressing the land-to-mouth ratio, say proponents. Growing food in the asphalt jungle could help return stability to an easily perturbed agriculture sector, one where increased demand for a single crop, such as corn, is felt from movie theaters to hog farms. And urban farming enhances a city's ability to deal with hazards and disasters, Lawrence says.

"In the developed world our entire system of getting food to people has to do with just-in-time delivery," he says. "Our trucking systems have to work; our trains have to work. No one has inventory anymore. We saw the most tragic example of this in New Orleans with Katrina. As a community becomes isolated, how do they feed themselves?"

Despommier envisions buildings where water is recycled throughout, nonedible plant parts are composted and methane is collected and turned into heat. Water from pools holding freshwater fish, such as trout and striped bass, is filtered and routed to peppers and strawberries, which are pollinated by resident bees. Chickens cluck on one floor while pigs snuffle about on another — their waste turned into pellets that become an energy source.

The idea appears immensely practical from a food production point of view, but Despommier doesn't stop there. Vertical agriculture offers the promise of urban renewal, he says. Abandoned properties become vibrant neighborhood centers. The first floor of each building might host a farmers market, providing jobs along with fresh, healthy produce.

Ecobenefits

Then there are the ecological benefits of subverting the dominant agricultural paradigm. A parasitologist by training, Despommier points out that turning forest into farmland can unleash infectious diseases and enhance their spread. Traditional farming has left waterways polluted with fertilizer and pesticides. Recent analyses find that topsoil is eroding 10 times faster than the natural replenishment rate in the United States, and in China and India it is 30 to 40 times faster than the natural rate.

The Living Skyscraper, illustrated here, is one vertical farming concept put forth by architects and engineers. Proponents envision cities that grow their own food all year, reducing the environmental toll wrought by conventional farms.

ILLUSTRATIONS BY BLAKE KURASEK

Vertical farms would soften the blow of traditional farming, says Despommier, giving injured land the chance to heal.

"I want to put trees back on the land. I want to be the Lorax," he says, referring to the mustached Dr. Seuss character who "speaks for the trees."

Despommier's vision and enthusiasm hint at the quixotic. Taped to the edge of his desk is a yellowing fortune from a cookie eaten long ago: "Nothing is impossible to a winning heart." The vertical farm project's website (www.verticalfarm.com) asks, "Don't our harvestable plants deserve the same level of comfort and protection that we now enjoy?"

In a year of near-record flooding in parts of the Midwest and Northeast, the question seems less tongue-in-cheek.

"What happens outside is lightning bolts strike; there are floods, pests, drought," says Despommier. "You can control everything indoors. You can't control anything outdoors."

Plant growth in indoor environments can now be controlled with unprecedented precision, as can the environments themselves, says Gene Giacomelli, director of the Controlled Environment Agriculture Center at the University of Arizona in Tucson. The center's current research projects include refining a technique that limits water to the precise amount needed for growth. In this setup, known as deep flow hydroponics, the plants float on a body of water, completely covering the surface. With the right software and an Internet connection, scientists can monitor the pH, amount of nutrients, dissolved oxygen, air temperature, humidity, light intensity and CO_2 from a distance.

But as a scientist involved with developing greenhouses for the South Pole, the moon and Mars, Giacomelli is familiar with the difficulties of growing things where they don't usually grow.

"If I was going to play devil's advocate, I'd say it is going to be tough," he says. "You're forcing a building, which typically wants to be low humidity — to have dust rather than mildew — to be something that needs high humidity. At the end of the day it is going to be raining in these buildings."

Climate control is an issue for both the structure and its inhabitants. Plants can be finicky creatures. Some, such as lettuce, prefer cool weather, while melons and tomatoes like it warm.

Lighting is another factor. The majority of edible crops are what gardeners call "full sun" plants. Evenly distributing light across all plants — so all can go about their photosynthesizing business without burning or shivering — is no small task, Giacomelli says. Renderings of vertical farms often incorporate artificial light, preferably cast by light-emitting diodes, or LEDs. These are enormously more efficient than incandescent bulbs, which exude about two-thirds of their energy as heat, not light.

Scientists at NASA and elsewhere are fine-tuning LEDs to emit light in the wavelengths best for plants, which research suggests is mostly red and blue light. (Scientists at the Kennedy Space Center found that with no green light, their lettuce looked purplish-gray, making monitoring plant health difficult. Adding 24 percent green light enhanced growth and improved aesthetics.)

"LEDs are coming on strong — they work very well from a biological standpoint," Giacomelli says. "But for now, they just aren't as cost effective as a high-pressure sodium lamp."

Giacomelli sees light distribution, climate control and the integration of cooling and heating systems as vertical agriculture's primary challenges. He doesn't doubt it can be done — the greenhouses at the South Pole produce enough veggies that the core group of 50 to 70 people can have a fresh salad at least once a day, every day of the year. But any farming in a controlled envi-

Controlling the environment in vertical farms, including the arrangement of various crops, is critical to success. The light, temperature, humidity and pollinator preferences of plants are among the important considerations.

ronment requires a serious mechanical thumb in addition to a green one, he says.

It isn't clear whether vertical farming will ever be realized, but the idea does have legs. In May, at the World Science Festival in New York City, Despommier presented the vertical farm project to an audience peppered with Nobel laureates. He has been contacted by an MIT professor who wants to include vertical farm designing in his capstone course.

Financial obstacles

Even if the idea takes off, actual construction of a vertical farm is probably years away — estimates range from five to 15, at least. A building-sized stumbling block is cost.

One financial issue to contend with is competition with more lucrative structures, says New York Sun Works' Linsley. "With urban farming the biggest challenge is finding land," he says. The low yield and profits from a single-story, ground-level greenhouse can't compete with the profits offered by development. The condo always wins.

And single-story — or single-rooftop — gardens can't feed the masses. This realization was the seed that bloomed into vertical farming, says Despommier. In his ecology course at Columbia, students were tasked with calculating the amount of food they could grow if all of Manhattan's residential rooftops were gardens. The math said these roofs could provide a paltry 2 percent of the caloric needs of New York City.

There are many benefits to outfitting buildings with living roofs, Despommier says. "But the fact is, rooftop gardening is a trivial activity when you look at food production."

Their naïve enthusiasm crushed, his students became surly but then bounced back with vigor. Not only does New York have plenty of rooftops, it has plenty of abandoned buildings — why not farm from basement to penthouse?

The cost — in both dollars and emissions — of retrofitting old buildings, or building new ones from scratch, is so great that it is hard to imagine getting any environmental bang for the buck,

Swiss chard flourishes sans soil in the Science Barge. Nutrients added to water circulate among the crops.

says Christopher Weber of Carnegie Mellon University in Pittsburgh. Weber, who investigates environmental impacts of food production and consumption, says the assumptions that vertical agriculture proponents begin with are faulty.

"We are not running out of land. We could easily grow twice as much food as we are currently growing," he says. And that's under today's inefficient regime. As changes happen in the current system — shifting from grain-fed to grass-fed cattle, for example, or improving efficiency by tailoring crops to the local environment — there will be even more land available for food production.

For those who can't wait for the urban farms of the future, rooftop gardens that use existing technologies can provide healthy produce and put urban dwellers in touch with food roots, Linsley says. The Science Barge, a brainchild of New York Sun Works and its sister company BrightFarm, offers a rooftop garden prototype, a public demonstration of urban farming that comes close to being carbon neutral. Two greenhouses sit atop an old barge, which for much of this summer was parked on the Hudson off the 68th Street pier. Roughly 80 percent of the barge's energy comes from two solar panels that track the sun. An array of tiny windmills and a biodiesel generator fill in the gaps.

Within the greenhouses are stacked towers of strawberry plants, rows of leafy greens such as chard and basil, and climbing peppers, melons and tomato plants. The plants are grown hydroponically; the essential nutrients are added to collected rain and river water, which is circulated among the plants with a series of tubes and gutterlike containers. Every month or so, when algae begin to gunk up the pipes, the crew cleans out the tanks and gutters. A bed of nonedible marsh grasses at the opposite end of the barge drinks the old water, closing the loop.

More than just an education center for local schools, the barge is a research center for urban agriculture. Sun Works is already using data from the barge in rooftop garden designs for three Manhattan schools. In addition to capturing storm water and preventing heat loss from the buildings, the gardens will provide fresh veggies for the lunchroom.

"We don't just want to prove to people that it works," Linsley says. As important as the proof of principle is the data gathering. A sophisticated array of sensors and machines records the patterns of energy use, which can be extrapolated out to larger projects and systems.

"A lot of people in the foodie world are wedded to organic techniques," Linsley says. "But they very quickly realize that we can't feed the world with organic techniques." Rural farming isn't going to disappear, he says, and crops such as apples and corn might never make sense in a greenhouse. Grow those crops organically where you can, and complement these organic farms with high-yield greenhouse production that is done sustainably, he says.

Along with all that environmentally friendly stuff, one of the most persuasive arguments for growing food in cities is obvious to anyone who has eaten a tomato that has been picked too soon and grown to survive a week in a refrigerated truck.

"People are very aware that food doesn't taste as good as it should," Linsley says. The produce grown on the Science Barge is a testament to what city-grown produce could and should be. "Our tomatoes are radically different." ■

Explore more

- Controlled Environment Agriculture Center at the University of Arizona, ag.arizona.edu/ceac/

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"My administration will increase funding for basic research in physical and life sciences, mathematics and engineering at a rate that would double basic research budgets over the next decade."
Barack Obama to Science Debate 2008

JOHN GRESS/REUTERS

The Scie

On the surface, the presidential contenders appear to take si differences emerge. Because Senators Barack Obama and don't intend to, *Science News* runs down what these candi

The Political Climate

Linking energy to greenhouse risks

Science and technology have not played out as major presidential campaign issues this year. And following Sen. John McCain's unexpected announcement that Alaska Gov. Sarah Palin would be his running mate, even foreign policy and major energy issues have been relegated to the back seat as the media feverishly probe the views, background and administrative history of Palin — a newcomer on the national scene.

But B.P. — before Palin — a diverse body of video clips, Internet-posted position statements and campaign remarks by McCain and Sen. Barack Obama had already emerged, and some did touch on S&T issues. Most focused on energy or the climate and shared common themes.

For instance, both candidates have described an urgent need to wean Americans from fossil fuels. An escalating risk of catastrophic climate change is one reason, but hardly the only one, the candidates give for their concern.

"Climate change is real," McCain said at the Clean Cities Congress in Phoenix as early as May 2006. "While there are still a few skeptics of climate change, the evidence supporting the causes of rising global temperatures as human-induced is overwhelming." Acknowledging that skeptics remain, he argued that "almost any credible organization will tell you that the evidence is growing and becoming clearer every day, despite the reluctance of the [Bush] administration to do anything meaningful about climate change."

Obama also contends on his website that the nation faces major challenges from global climate change and from a dependence on foreign oil, "both of which stem from our current dependence on fossil fuels for energy." As such, "we have a moral, environmental, economic and security imperative to address our dependence on foreign oil and tackle climate change in a serious, sustainable manner."

It's how each candidate would manage these problems that differs.

Both claim they would lower the nation's carbon footprint by shrinking reliance on oil. Explained McCain: "We face the reality that oil supplies will fall

nce Vote

milar stances on science and technology. But probe a bit, and John McCain have never formally debated S&T issues, and dates and their campaigns have been saying. **By Janet Raloff**

in this century.... Growing demand [for oil] and limited supplies mean one thing: higher prices. And that's particularly so for oil, which accounts for about half of gasoline's price at the pump." Last year, he said that "the answer to high gas prices cannot be to produce more oil.... Gas prices are nothing less than a call to action to wean ourselves off of oil."

As those prices bumped up dramatically this year, McCain modified his stance. He now enthusiastically backs new drilling at offshore U.S. sites, especially in the Atlantic and Gulf of Mexico.

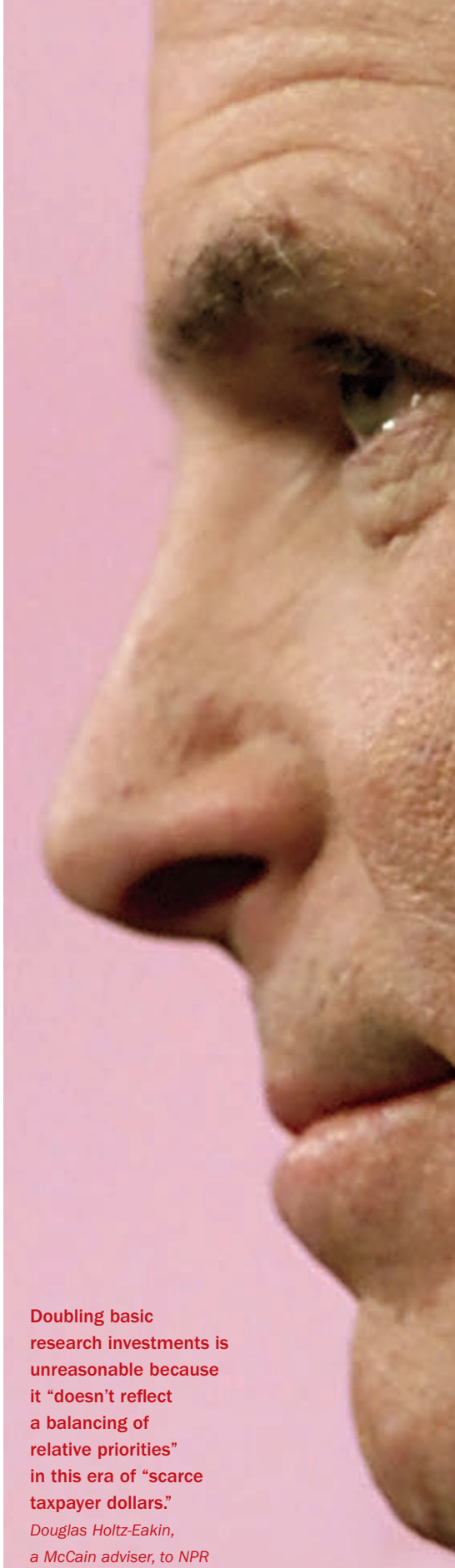
Obama's energy strategy also calls for cutting oil use within the next decade. In his case, it would be by an amount that exceeds what the United States now imports from the Middle East and Venezuela — some 3.7 million barrels per day.

Although he has not been much of a proponent of oil drilling as a route to energy independence, Obama applauded an August 1 proposal floated by a bipartisan coalition of Senate colleagues, the "Gang of 10." That group wants to dramatically increase oil drilling off U.S. coasts (see the August 2 Science & the Public blog at www.sciencenews.org), he noted, and "would repeal tax breaks for oil companies so that we can invest billions in fuel-efficient cars, help our automakers retool and make a genuine commitment to renewable sources of energy like wind power, solar power and the next generation of clean, affordable biofuels."

No amount of drilling will sate America's escalating appetite for electricity. McCain would end what has essentially been a roughly 30-year moratorium on utilities' purchases of new nuclear plants. "Nuclear power is a key technology for addressing climate change," he said at the Clean Cities Congress. "We simply cannot ignore this emissions-free technology."

Obama's proposed energy policy, unveiled in an August 4 speech, similarly argues that "it is unlikely that we can meet our aggressive climate goals if we eliminate nuclear power as an option." However, he argues, before pushing for greater reliance on this source, "key issues must be addressed including: security of nuclear fuel and waste, waste storage and proliferation." He has already introduced legislation proposing new guidelines to track, control and account for used fuel from commercial power plants. And if he had his way, Obama would scrap longstanding plans to make Nevada's Yucca Mountain the nation's storage depot for high-level nuclear-waste.

In addition, Obama would invest in advanced automotive vehicles — and



REUTERS

Doubling basic research investments is unreasonable because it "doesn't reflect a balancing of relative priorities" in this era of "scarce taxpayer dollars."
Douglas Holtz-Eakin, a McCain adviser, to NPR

Obama

Nuclear Energy

Although "it is unlikely that we can meet our aggressive climate goals if we eliminate nuclear power as an option … key issues must be addressed including: security of nuclear fuel and waste, waste storage and proliferation."

Science Education

"There's a difference between science and faith.… And I think it's a mistake to try to cloud the teaching of science with theories that frankly don't hold up to scientific inquiry."

Biomedical Funding

Obama pledged to increase funding for NIH, the Centers for Disease Control and Prevention and the Agency for Healthcare Research and Quality. He also volunteered that the FDA is badly underfunded.

push for deployment, during the next eight years, of a million plug-in hybrids that get more than 150 miles per gallon in short-haul driving. Half of Uncle Sam's auto purchases by 2012 would have to be plug-in hybrids or fully electric vehicles. And as a carrot to consumers, Obama's administration would propose a tax credit of $7,000 for purchasing such advanced-tech vehicles.

Within four years, under his plan, renewable energy sources such as wind, solar and geothermal should grow to power 10 percent of U.S. electricity — up from roughly 4.1 percent today. Obama would also instruct the Department of Energy to enter into public-private partnerships for the development of five "first-of-a-kind" commercial-scale, coal-fired power plants that pioneer new technologies for carbon capture and sequestration, and mandate that all new vehicles by 2012 be able to flexibly switch between gasoline and blends containing biofuels.

Finally, Obama said during his energy speech that he would increase automotive fuel efficiency standards 4 percent annually. This alone, the Obama campaign says, "would save nearly a half trillion gallons of gasoline and 6 billion metric tons of greenhouse gases." McCain, by contrast, has argued against mandatory increases in automotive fuel-efficiency standards.

At an April 11 briefing in Washington, D.C., McCain adviser R. James Woolsey noted that his candidate is considering a carbon dioxide reduction package that would also focus on developing plug-in hybrids, mandating flex-fueled vehicles and helping automakers retool their vehicles to weigh less and guzzle fewer gallons per mile.

Woolsey, CIA director under President Bill Clinton, noted that his candidate's energy policy remains a bit vague on details because McCain wants the government "to have a general direction — such as away from carbon, which he strongly promoted, or away from old wasteful subsidies — but not get into the business of picking winners." That is, not specifying which technologies to back.

Research and Education

Spending priorities differ

Federal funding for academic research — a major engine of innovation — has experienced an "unprecedented" two-year decline, the National Science Foundation reported in late August. Between fiscal years 2005 and 2007, Uncle Sam's share of academic research funding fell from 64 percent to 62 percent. To take up the slack, universities turned to industry backers and others. Universities have also "tapped into their own endowment and gift funds," according to a report in the Aug. 25 *Inside Higher Ed.*

"If we don't fund basic research at a high enough level, over time it will catch up with us," diminishing research payoffs in terms of ideas, products and spin-off technologies, says Samuel M. Rankin III. Associate executive director of the American Mathematical Society, in Washington, D.C., he's also a spokesman for the Coalition for National Science Funding.

Obama told the Science Debate 2008 committee (a group that unsuccessfully called for the major presidential candidates to debate on S&T issues) that he would double federal funding for basic research — pioneering studies for which applications may not yet be apparent. He would also "put basic defense research on a path to double."

Douglas Holtz-Eakin, a McCain adviser, agrees with charges that President George W. Bush's policies have amounted to a war on science. "This is a sad era in that regard," he said in August in a National Public Radio interview. He added, however, that McCain believes that Obama's call for doubling basic research investments is unreasonable because it "doesn't reflect a balancing of relative priorities" in this era of "scarce taxpayer dollars."

Stacie M. Propst of Research!America, a biomedical advocacy group based in Alexandria, Va., points to similar variances in responses to policy questions her group sent to the candidates.

Take the National Institutes of Health. She says inflation has eroded the buying power of its research budgets. McCain told her group that he strongly supported funding for NIH — and for the Centers for Disease Control and Prevention and the Agency for Healthcare Research and Quality. However, McCain's campaign did not check a box saying he would increase funding for any of these agencies.

In contrast, Obama checked boxes to increase funding for all three agencies. He added that the FDA is badly underfunded, urgently needs better experts to inspect food and other regulated products, and must abolish "pressures to silence internal drug-safety critics" or attempts to protect drug companies from product liability.

In general, Propst says, there are many "commonalities" in the candidates' attitudes toward biomedical research, including the favoring of an expansion in federal

funding for embryonic stem cell research. However, McCain's answers do suggest "a pretty big distinction, in our minds," from the aggressive support for research evinced by Obama's responses, she says.

Interpretative differences also emerge in the candidates' attitudes toward evolution. Although both profess to believing in it, they differ on the appropriateness of teaching creationism — sometimes portrayed as "intelligent design" — in public schools. Obama told the *York Daily Record* in Pennsylvania that "there's a difference between science and faith.... And I think it's a mistake to try to cloud the teaching of science with theories that frankly don't hold up to scientific inquiry."

In contrast, McCain's campaign told the Christian Broadcasting Network last year that "McCain believes evolution is supported by science, but that we shouldn't be afraid to expose students to other theories." Two years earlier, McCain said much the same thing in a videotaped meeting with staffers from the *Arizona Daily Star*. When asked whether children should learn about intelligent design in science classrooms, McCain responded that plenty of scientists think so — and "all points of view should be presented."

Both candidates strongly support the space program and value domestic development of innovative technologies, and both would continue aggressive wetlands preservation. However, Obama's campaign has released far more data on its candidate's S&T views and education proposals than has McCain's.

For instance, Obama told the Science Debate 2008 group that he would "guarantee" students have access to strong science curricula at all ages "so they graduate knowing how science works using hands-on, IT-enhanced education." He also vowed to launch a scholarship program to subsidize the education of teachers who commit to teaching in "a high-need school." Priority would go to those who would teach math and science. And new Teacher Residency Academies would place 30,000 educators at high-need schools, Obama said, "training thousands of science and math teachers."

McCain countered a week later with his S&T teacher proposal. He would reallocate federal Title II funding by earmarking more of it to reward high-performing teachers, principals and schools. Priority, he told Science Debate 2008, would go to teachers working in the "most challenging educational settings and who teach science or math." He would also set up a $250 million competitive grant program for states that commit to expanding online education opportunities.

Obama has posted a detailed technology agenda. Among its goals: making broadband Internet access universally available; increasing the "transparency" of federal decision making by posting almost all documents and broadcasting most meetings online; and appointing the nation's first Chief Technology Officer, who would ensure that all federal agencies seamlessly communicate their data internally and with the public. That's a tall order, but points to Obama's recognition of how integral Internet access and data-searching have become for most Americans.

McCain, in contrast, boasts about his low-tech lifestyle. In a brief interview posted on YouTube, Mike Allen of Yahoo! News asked McCain whether he used a PC or Mac computer. His answer: "Neither. I am an illiterate that has to rely on my wife for all of the assistance that I can get." Many tech pundits and bloggers latched onto this professed discomfort with the cyberworld as a likely reason for McCain's sketchily detailed tech policy.

Albert H. Teich, Science & Policy Programs director at the American Association for the Advancement of Science, in Washington, D.C., has expressed concerns over the degree of McCain's comfort with technology and over his misunderstanding of science and its value.

For instance, Teich notes, the candidate has repeatedly lambasted a federal study for analyzing DNA in grizzly bear fur. Researchers outside the project have generally argued that the study's data could prove extremely useful to conservation of this animal — an elusive species threatened with extinction. Its population may total only 1,500 individuals throughout the lower 48 states. Yet McCain jokes that these studies must have been for paternity tests. Calling the work frivolous, McCain's TV ads argue that the research should be abolished.

Such assertions haven't gotten a lot of attention, Teich says, "but for me they're bright lines" calling into question McCain's science literacy.

Then again, with the notable exception of British chemist Margaret Thatcher, most world leaders don't consider science one of their strengths. Indeed, that's why most surround themselves with legions of expert advisers. ■

McCain

Nuclear Energy

"Nuclear power is a key technology for addressing climate change. We simply cannot ignore this emissions-free technology."

Science Education

When the *Arizona Daily Star* in 2005 asked McCain whether children should learn about intelligent design in science classrooms, McCain responded that plenty of scientists think so — and that "all points of view should be presented."

Biomedical Funding

When asked about biomedical agencies, McCain said he strongly supports funding for NIH, the Centers for Disease Control and Prevention and the Agency for Healthcare Research and Quality.

Explore more

- **www.sciencenews.org/TheScienceVote** Visit this site to read a list of both candidates' answers to Science Debate 2008, along with their answers on biomedical research, analyses of the role of science issues in the campaign and the *Science News* blogs "McCain is bullish on research" and "Obama likes research."

Dead–but not duds

White dwarfs shed light on physics and the fate of the cosmos

By Ashley Yeager

Amid the liveliest stars in the cosmos lie stellar corpses. Of these dead stars, the most abundant are white dwarfs — stars that in their prime were similar to the sun. These dense corpses foreshadow what will become of most of the stars in the universe.

Although white dwarfs are dead, they aren't useless. Postmortem examination shows they have different masses and different chemical makeups. Some are strongly magnetic. Others pulsate. A few even have orbiting planets and debris disks. "Understanding why these cadavers are all different might help us understand the lives of normal stars," says Patrick Dufour, an astronomer at the University of Arizona in Tucson. "And although we think we know how stars evolve and die, there are still many things we don't understand in detail."

That is why Dufour and others perform what he calls a "kind of autopsy" on these stars. But unlike human pathologists who can carry out up-close and personal inspections, white dwarf astronomers are limited to their sense of sight and telescopes to dissect their corpses.

Among the most intriguing of white dwarfs are the ones that pulsate, says Donald Winget, an astrophysicist at the University of Texas at Austin. Lately new telescopes have provided astronomers a better glimpse of these particular corpses, opening a window to unexplored, exotic physics. Studies of pulsating white dwarfs promise insight into the dark matter hiding in the cosmos, provide valuable data on the expansion of the universe and offer clues about whether exoplanets can survive the death of their parent star.

Taking a pulse

So far, astronomers have discovered three families of white dwarfs, which, on average, are about the mass of the sun and fit into a space about the size of Earth. That mass-to-space ratio makes these stars extremely dense, about 200,000 times Earth's density. What distinguishes one type of white dwarf from another is its veneer. This outer coat may be composed of hydrogen, helium or, as Dufour discovered last year, carbon. Then in May, Winget and his colleagues found that one of these new carbon-veneered white dwarfs pulsates too.

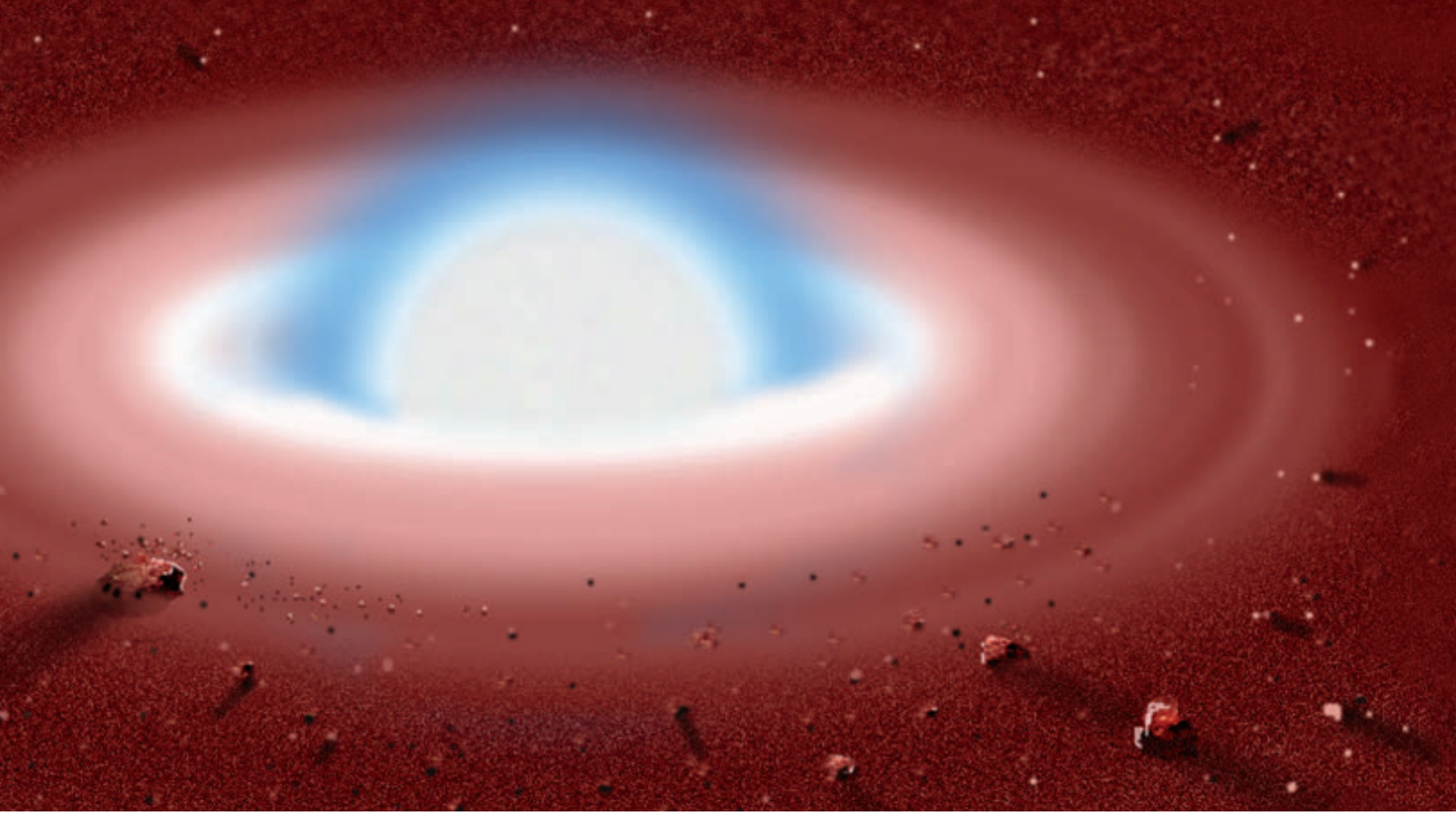
Thinking about a pulsating white dwarf might elicit imagery of a star expanding and contracting. But pulsating white dwarfs do not throb this way. Because of their strong gravity, much of the motion is a "sloshing" of material around the star, not an in-and-out motion, says astrophysicist Agnes Kim of Georgia College & State University in Milledgeville.

When the material "splashes" together on the star's surface and that region becomes hot, astronomers see the pulsations as a brightening, Kim says. Where the stellar material pulls apart, the temperature drops, and astronomers see the region dim.

Measuring white dwarf pulsations is similar to measuring seismic waves traveling through the Earth. Because parallels exist between seismological vibrations and white dwarf vibrations, astronomers dubbed the technique asteroseismology. Winget thinks of the stars' vibrations in terms of hearing a bell. "From its ring you can tell the size of the bell and what it is made of," he says. "How it shakes or vibrates tells about its structure." Similarly, measuring light vibrations reveals data about a white dwarf's structure and chemical composition.

"But white dwarfs aren't doing any nuclear reactions. They have no energy

JON LOMBERG, GEMINI OBSERVATORY



An artist's conception shows what a planetary disk surrounding a white dwarf might look like.

source," notes Michael Montgomery, an astrophysicist and a colleague of Winget's at UT Austin. "So, it's like when you take a hot lump of coal out of the fire; it just sits there and cools off. These stars are like those lone lumps of coal. They are just sitting there cooling off."

Montgomery explains that of the white dwarfs that pulsate, a subset of them pulsate so regularly that astronomers can use the dead stars as precision timepieces. "They hardly lose any time at all," he says. In fact, the record for the least time lost by a white dwarf is one second every 10 million years.

"I think of these stars like a *heated* bell," Kim says. "As the bell's metal cools, it will change temperature and density, and therefore the sound, the pitch of it, will change slightly. The same is true for the white dwarf, so the frequency of the light pulses change slowly too."

Kim's research uses pulsating dwarfs to look for clues to the nature of the dark matter that lurks unseen in space. Digging through the observational literature, she found 30 years' worth of data tracking one dwarf's pulsation and cooling. She observed the star and correlated how fast its pulse periods were changing with how fast it was cooling and determined how much energy the star should be losing.

The measurements allowed room for extra cooling from unseen particles, she says. For her doctoral thesis last year, Kim argued that the star was giving off subatomic particles including neutrinos and the theorized, but undetected, axion. Axions were "invented" to solve a problem in the standard model of particle physics, which describes nature's forces and the basic building blocks of matter. Axions could also make up the dark matter needed to explain unexpected motions observed in galaxies and galaxy clusters.

Not much is known about the particles, though, since, if they exist, they have so far eluded physicists' traps. To place a limit on how massive axions could be, Kim began by assuming that they were released as a white dwarf lost heat. Axions cannot contribute too much to cooling. Otherwise, "we would definitely see the pulse periods change faster than we do," she says. She concluded that the axion mass should be less than 25 millielectronvolts, or meV. An electron's mass is around 500 kiloelectronvolts, roughly 20 million times greater. The findings appeared in *The Astrophysical Journal* in March. (The preprint of the paper is online at arxiv.org/abs/0711.2041.)

More recently, Jordi Isern of the Blanes Advanced Studies Centre's Institute of Space Sciences in Bellaterra, Spain, and colleagues lowered Kim's upper limit on the axion mass to 5 meV, using a different method still based on light from white dwarfs. The results appeared in the Aug. 1 *Astrophysical Journal Letters*.

"The jury is still out on these results, and the Spanish authors admit there are many things they did not take into account," Montgomery says.

Techniques used to put mass limits on particles are not limited to axions. Astronomers can predict upper mass limits for neutrinos and other proposed dark matter candidates too, Kim says. Finding a limit for the particle candidates' masses is a first step to figuring out what dark matter is, Winget says.

Ending in style

White dwarfs have already played a role in discovering another of the universe's dark secrets — dark energy. That's the term astronomers use to describe a mysterious force causing the universe to expand at an accelerating rate.

Evidence for dark energy came in the 1990s from studies of type 1a supernovas, believed to occur when a white dwarf explodes after stealing matter from a nearby companion. So much mass piles up on the white dwarf that its core can no longer support its mass, leading to nuclear detonation in a flash as bright as a billion suns.

Because white dwarfs should all explode after reaching a similar mass — about 1.4 times the sun's mass — the explosions should all produce about the same brightness. So astronomers consider white dwarf supernovas "standard candles" for measuring distances to far-off galaxies. Since light from distant galaxies represents conditions in the universe long ago, studying these explosions can reveal details of cosmic history. To astronomers' surprise, supernova data showed the universe's expansion was accelerating, not slowing as previously believed.

Further explanations for the cause of the acceleration require more precise data about white dwarf supernovas. It turns out that they do not really all explode with the same brightness, so astronomers need more information on the mass and makeup of white dwarfs, and on how they explode, to make appropriate corrections in the calculations.

"We have come to realize that these supernovae explode by the same mechanism, but there are different things going on. Some explode at a slightly smaller mass, some at slightly heavier mass," says astrophysicist Sumner Starrfield of Arizona State University in Tempe. "And the truth is, we just don't know what the stars that lead to supernovae are like because the explosions are hard to observe."

White dwarf pulsations, minor changes in light output over time, help astronomers probe the nature of dark matter, investigate dark energy and search for distant Earthlike planets.

In February, astronomers from Germany and the Netherlands reported in *Nature* on a supernova in a binary system including a white dwarf, supporting the standard view that type 1a supernovas involve the dead stars. Determining what the parent stars of such supernovas are made of would be possible if astronomers could find a binary system in which one of the partners was a pulsating white dwarf, and could study the system before it exploded. In such cases, the pulsating dwarf would give astronomers a "long-handled spoon for studying these stars' interiors," Starrfield says.

Astronomers might be able to use that long-handled spoon not only to get a taste of white dwarf interiors, but also to investigate the possibility of planets or other objects orbiting the star.

Getting around

About three years ago, astrophysicist Eric Becklin, now at NASA Ames Research Center in Moffett Field, Calif., and collaborators found dusty debris disks around five white dwarfs. All five dwarfs showed traces of metal nearby. "Solitary white dwarfs don't have these metals," Becklin says. "The metals could have never formed in these stars, so basically this tells us that asteroids and maybe even planets are going around these former sunlike stars."

Further evidence for whether an object orbits a white dwarf could come from studying the timing of the stellar corpse's pulsations. Because time can be tracked with such precision, astronomers know exactly how many seconds or minutes should elapse between one pulse and the next — unless there is an exoplanet lurking in the shadows.

If a big object is going around the white dwarf, Montgomery says, it pulls the star slightly closer or slightly farther away from Earth depending on where the planet is in its orbit. When this happens, the light from the white dwarf has to travel either slightly less or slightly more distance to reach Earth. "So some of the pulses will come early," says Fergal Mullally of Princeton University. "And sometimes, pulses will be late."

Looking for those signature changes in pulsations in 15 white dwarfs, Mullally has so far found only one beginning to show the patterns expected when an exoplanet orbits the star. "The problem with white dwarfs is that we should be finding planets like Jupiter, meaning they have an orbit that takes several years," he says.

Mullally has been tracking his candidate star for about five years but has only seen half to two-thirds of the signature light pattern a planet's presence should show. Soon the pulsations should show a delay. If they do, that would complete the planet's signature pattern, he says.

Further prospects for success in finding planets around white dwarfs comes from Roberto Silvotti of the Osservatorio Astronomico di Capodimonte in Naples, Italy, and colleagues. Last year in *Nature*, they reported that they found a planet three times the mass of Jupiter orbiting a star on the road to white dwarfhood. During death, the star expanded, almost engulfing its planet with its gases. The star lost all its hydrogen, shrunk to half its size and now fuses helium and carbon. The surviving planet suggests that planets like Earth could endure the violent death of their parent stars. To confirm the idea, astronomers would need to find planets around an actual white dwarf, Winget says.

Another way to seek signs of these planets could emerge from the metallic, dusty debris disks surrounding Becklin's white dwarfs. Three of those stars pulsate. Astronomers would like to find a signature variation in the light pulses that might characterize the debris disks.

Winget says he and others could then look at the light signatures from the roughly 200 pulsating white dwarfs so far discovered and figure out what fraction of them have orbiting asteroids, debris disks and possibly even planets.

"This is an important area," Winget says, "because we ultimately learn more about the fate of solar systems." And maybe, he adds, "we could even better understand what will happen to our own." ■

Explore more

- White Dwarf Research Corporation, www.whitedwarf.org

K. WILLIAMS, T. JONES, MCDONALD OBSERVATORY; ADAPTED BY J. KORENBLAT

Only in the north

It is not clear in the fine article on volcanoes ("Disaster goes global," *SN: 8/30/08, p. 16*) how dust from the eruption of Huaynaputina, well south of the equator, in 1600 could affect only the Northern Hemisphere.
David Bronson, Biddeford Pool, Maine

For one thing, there's less real estate in the Southern Hemisphere to have been affected. Also, the apparent lack of agricultural effects probably stems from population distribution at the time this eruption popped off. Australia was inhabited only by Aborigines until 1787 or so, and Cape Town, South Africa, wasn't settled until the mid-1600s. There's also a dearth of written records for the hemisphere from that time. Research examining tree rings and other climate proxies at Southern Hemisphere sites would probably show effects from the eruption in that half of the world too. —Sid Perkins

Not so small

Contrary to the title and the first sentence of the article, hydrogen is not "the smallest atom of them all" ("Spotting the smallest atoms," *SN: 8/16/08, p. 7*). Atoms with more numerous electrons display decreasing radii. As there is one proton for each electron and because the size of the proton is negligible compared with the atomic radius, the increasing number of protons in the nucleus increases the positive charge of the nucleus, drawing the electrons into tighter orbitals. Thus helium, with two protons, has the smallest atomic radius and is followed by hydrogen.
Simcha Pollack, Jamaica, N.Y.

The size of atoms can be measured or calculated in different ways, says Jannik Meyer of the University of Ulm in Germany. Under a transmission electron microscope, atoms "look" larger if their nuclei have more electric charge, which makes the atoms scatter the microscope's electrons. "In our work all that matters is how much the atom scatters electrons," Meyer says. "Hydrogen is the lightest element, and it has the smallest charge." —Davide Castelvecchi

Just checking

In regards to the phone conversation between Alice and Bob during which they compare the keys they have received from Charlie ("Welcome to the quantum Internet," *SN: 8/16/08, p. 24*): If the keys do not agree, Alice and Bob conclude that someone (Eve) has interfered, and it is clear that they cannot use the key. But what if someone listens in on the telephone conversation?
Steven Africk, Newton, Mass.

Alice and Bob only use a random subset of the strings of 0s and 1s for a spot check. (They agree to check the same subset. Bit No. 7, bit No. 21, bit No. 33 and so on, for example.) Eve doesn't know in advance which subset they're going to check. If the spot check shows no signs of eavesdropping, Alice and Bob use the remaining bits — the ones they haven't compared over the phone — as their key. —Davide Castelvecchi

The migrating eye

Regarding "The wandering fish eye" (*SN: 8/2/08, p. 11*): As I understand Darwinian theory, it basically says that a random change in an organism, if it confers a survival advantage, will tend to be passed on to that individual's offspring, thus gradually increasing the population of that organism with that trait. I can understand why the present one-sided eye position is advantageous for flatfish. But how did the slightly migrated eye confer an advantage?
Clark Waite, Hurst, Texas

Adaptive questions are always tricky to answer. Some scientists speculate that a slightly migrated fish eye could have benefited fish that did not lie completely flat on the seafloor. These fish could have propped themselves up a bit with their fins, tilting their bodies. In this case, any movement of the eye would give the fish a better view. Another possibility is that a shifted eye would avoid contact with the seafloor after a fish already began lying flat, preventing damage to the eye. In this scenario, only later in evolutionary history would the eye shift become important for improved vision. —Ashley Yeager

Correction: *An article in the August 30 issue ("Team toys with ions to simulate quantum world,"* SN: 8/30/08, p. 5*) incorrectly says that the number of spin states of a 100 particle system, 2^{100}, is greater than the number of protons in the known universe. The article should have said 2^{300}, the number of spin states of a 300 particle system, is greater than the number of protons, about 10^{80}, in the universe.*

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A History of Paleontology Illustration

Jane P. Davidson

The first artist to depict a fossil didn't even realize he was doing so: The "tongue stones," actually fossilized shark teeth, were natural curiosities thought by many in the 15th century to offer protection against illness and snakebite.

Although artists have been creating pictures of fossils for more than 500 years, Davidson's book is the first to comprehensively tackle the topic of how those remains have been portrayed through the ages. This richly illustrated volume follows the development of paleontological art from ancient woodcuts, etchings and paintings to modern photography and 3-D digital renderings.

Throughout its history, paleontological art has been suffused with a desire for visual realism and a careful attention to detail, the author argues. These characteristics lend the illustrations an aesthetic all their own, whether showing the fossils, the organisms or the environments in which the organisms lived.

Paleontological artists use illustrations not only to transmit detailed information among researchers but also to arouse interest and spread information among the public: What schoolchild doesn't get a thrill out of the latest sketch of *Tyrannosaurus rex*?

While the book focuses on scientific illustrations, it also describes significant works of art seen in popular venues such as museums and other public displays. In many instances, discussions of images include historical significance as well as biographical details of the artists and their times.

The scientific revolution that has recently transformed dinosaurs from lumbering, slow-witted reptiles to agile creatures has influenced depictions in print and art, as well as those in movies such as *Jurassic Park* and television series such as BBC's *Walking with Dinosaurs*. — *Sid Perkins*

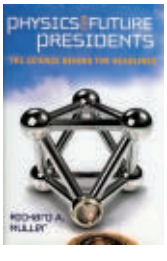
Indiana University Press, 2008, 217 p., $39.95.

Physics for Future Presidents: The Science Behind the Headlines

Richard A. Muller

The next president of the United States won't have a physics Ph.D. — but he will develop policy on physics-related matters.

In this election year, Muller, a professor at UC Berkeley, has put together a guide for the country's incoming leader. But the purpose of the book is primarily to inform voters. Muller shares statistics and corrects misunderstandings relating to terrorism, energy, nuclear weapons, space and global warming.



Muller writes for the educated reader, not the physics expert. Readers, for example, might be surprised to learn that gasoline is one of the most useful weapons for terrorists: It is low-tech and easy to get, and one ton releases the explosive energy of 15 tons of TNT, Muller writes.

But the way Muller relates principles of physics to political policy will interest scientists as well. He explains that the explosive energy of fuel in a jet crashing into a building suggests leaders should focus on preventing terrorists from flying planes, rather than worrying that terrorists will create nuclear weapons.

Muller even-handedly acknowledges disagreements over interpretations of data. He writes that "global warming is real. It is very likely caused by humans." But he also criticizes people who distort information for emotional impact.

If you're seeking the basics or looking for policy suggestions based on sound scientific reasoning, this book offers enlightenment — whether you expect to one day be a world leader or not. — *Heather Benjamin*

W.W. Norton & Company, 2008, 380 p., $26.95.

Falcon Fever: A Falconer in the Twenty-first Century

Tim Gallagher

An intimate look at the tradition and subculture of falconry.

Houghton Mifflin, 2008, 326 p., $25.

Miscarriage, Medicine & Miracles

Bruce K. Young and Amy Zavatto

A leader in obstetrics and gynecology explains how to prevent and deal with miscarriage.

Bantam Dell Publishing, 2008, 334 p., $25.

Reign of the Sea Dragons

Sneed B. Collard III

Kids will learn about the monsters that swam in the seas while dinosaurs roamed Earth.

Charlesbridge, 2008, 61 p., $17.95.

Solving Stonehenge: The New Key to an Ancient Enigma

Anthony Johnson

This prehistoric monument still holds undiscovered clues to the past.

Thames & Hudson, 2008, 288 p., $40.

The Primate Family Tree: The Amazing Diversity of Our Closest Relatives

Ian Redmond

A portrait of lemurs, monkeys, apes and others, with color photographs and a foreword by Jane Goodall.

Firefly Books, 2008, 176 p., $35.

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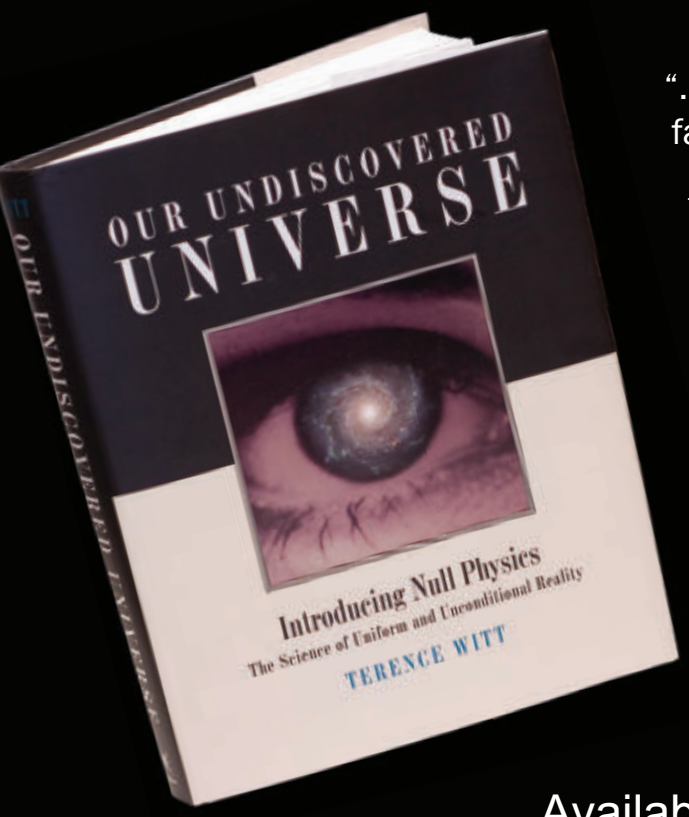

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‘National Greatness’ versus real national greatness

In 1993, the U.S. Congress cut off funds for the Superconducting Super Collider, or SSC. After years of planning, two years of major construction and $2 billion spent, the most enduring achievement of the still-born project was a tunnel from nothing to nowhere near Waxahachie, Texas.

The SSC would have enabled us to explore nature in more extreme conditions — higher concentrations of energy — than ever before. It would have yielded fundamental new insights into the origin of the universe and the nature of matter, space and time. Thousands of scientists devoted big parts of their careers to the SSC project.

From the ashes of that debacle, a phoenix now rises. The Large Hadron Collider, or LHC, a roughly equivalent instrument, has begun to operate at Europe’s CERN laboratory. Within the LHC’s 27-kilometer underground circular tunnel, two beams of protons will circulate in opposite directions at 99.999999 percent the speed of light. At a few points the beams will cross; there protons will collide with unprecedented violence. Detectors the size of jumbo jets, crammed with sensitive, agile electronics, will monitor those nano-microexplosions and feed observations into the Grid, an Internet on steroids ready to analyze petabytes of information as they gush forth.

Bigger, faster, smarter than anything previously attempted, the LHC is modern civilization’s answer to the pyramids of Egypt, but better: a monument to curiosity, not superstition, whose scale reflects function, not vainglory.

A consortium of European countries will have spent something in the neighborhood of $10 billion to build the LHC. (The U. S. contributed about $500 million, mainly to help build detectors.)

As the LHC surveys the territory that the SSC abandoned, the same discoveries will be made, albeit a decade delayed and datelined Geneva rather than Waxahachie. American scientists will share in the knowledge gained, and some will even participate in the experiments, while American taxpayers will be spared the bill.

Should Americans take pride in their cleverness, at getting others to do the work and foot the bill? I don’t think so.

The LHC is modern civilization’s answer to the pyramids of Egypt.

Even from a hard-nosed economic perspective, the picture is far from clear. Most LHC construction work was subcontracted locally, putting the money right back in circulation. Companies and workers in civil engineering, cryogenics, magnetism and electronics acquired cutting-edge expertise and experience. Over the medium-to-long term, building the LHC was probably a wise investment.

But suppose the LHC really was a net expense for Europe and the SSC would have been a net expense for America. We still should have done it.

By failing to follow through, we missed a rare opportunity to make a lasting statement about the sort of people we are (or used to be?) — a statement that people would continue to hear for as long as people remain curious about the physical world.

Explorers and immigrants populated America. Inventors and builders transformed a wilderness into a modern industrial civilization, opened it to the world and exported its fruits. The frontier defined our national character. Today our geographic frontiers have been tamed, but the uncharted frontiers of science are bigger than ever.

Before long, very likely, we’ll see headlines announcing that a great discovery — the cosmic molasses that is the origin of mass, evidence for unified field theories, the quantum dimensions of supersymmetry, the material that makes the astronomers’ missing matter, superstrings, braneworlds ... or some wonder that escaped the fertile imaginations of theoreticians — has occurred in Europe, at CERN. All humankind will share in the discoveries, and all should take pride in them; but Europeans will have earned glory.

Today there’s much talk about “national greatness,” usually defined in terms of winning wars and imposing our will on foreigners around the world. I think we’d do better to emphasize a different kind of greatness: a greatness that takes us back to our roots, emphasizing exploration, openness and (yes) generosity.

William James spoke of the moral equivalent of war: intense effort for large goals that can inspire, but need not involve conflict or destruction. We should aspire to be entrepreneurs in the business of advancing human knowledge, not free riders; producers, not parasites. We missed a chance for this sort of national greatness when the SSC became the LHC.

Let’s learn from that mistake. Other opportunities beckon: We could survey our part of the galaxy for Earthlike planets and see if their atmospheres display signs of life, or we could mount a full-scale scientific assault on the aging process, for example. Are we game for some real greatness? ■

Frank Wilczek of MIT is a Nobel laureate in physics and an incoming member of the Board of Trustees of Society for Science & the Public. frankwilczek.com

T. SIEGFRIED

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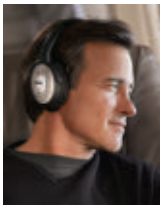

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