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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 20, 2008

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Clarity	"IF"	Clear
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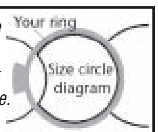

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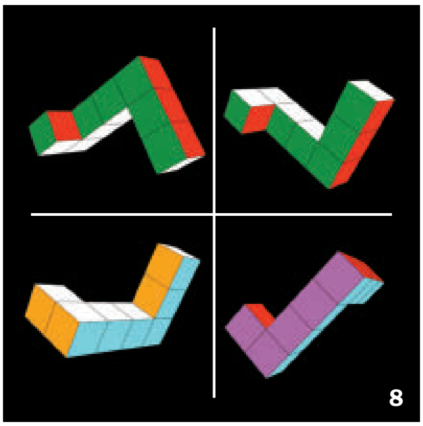

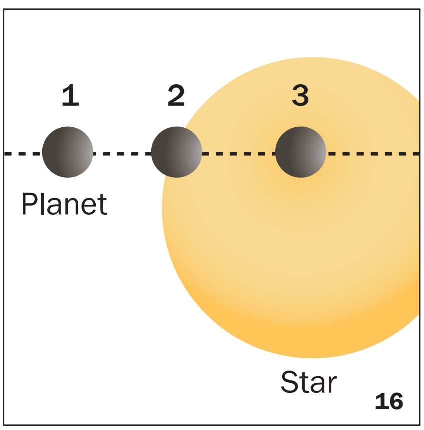

FROM TOP: CUSTOM LIFE SCIENCE IMAGES; ROBERT M. DITTO; ESA; BRYAN CHRISTIE

ScienceNews

In The News

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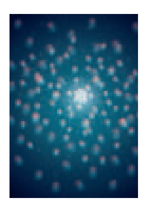

COVER Physicists have created nearly motionless ultracold molecules, including these composed of potassium and rubidium.
Greg Kuebler, JILA

ScienceNews MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

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FROM THE EDITOR

Successful science should inspire higher standards

Science seldom works as well as it's supposed to.

In principle, science should be the gold standard for acquiring reliable knowledge, using methods that eliminate prejudice and bias by conforming to universal standards of proper inference and verification.

In practice, of course, science's methods are applied by fallible people who don't always succeed in assessing the evidence impartially. No better example of science's shortcomings can be found than the reporting of clinical trials. As Rachel Ehrenberg describes in this issue (Page 14), studies of new medicines often don't get published. And among such studies submitted to the FDA by companies seeking drug approval, those unfavorable to the drug are less likely to be published than favorable studies. Even worse, sometimes the conclusion in a study provided to the FDA is changed when the study is published in the scientific literature. Something is going on there, and it is not science at its best.

On the other hand, sometimes science is spectacularly successful, even in the face of severe methodological difficulties. As Ron Cowen reports (Page 13), particle physicists have now succeeded in using their standard theory to accurately compute the masses of the proton, neutron and related particles.

Using the theory known as quantum chromodynamics (or QCD), the researchers were able to account for interactions between quarks and gluons — the subatomic inhabitants of protons and neutrons — in sufficient detail to show how those interactions generate the precise amount of mass that protons and neutrons possess.

Of course, physicists already knew what those masses are — by measuring them, a very important aspect of scientific procedure. You didn't need QCD to find out how heavy protons are. But the success of QCD in calculating that mass shows that scientists have achieved a deep level of understanding about how matter works.

And the achievement has its practical aspects, also. As Nobel physics laureate Frank Wilczek of MIT points out in a commentary in *Nature*, the calculation required an enormous computational effort, aided by sophisticated techniques for dealing with numerous necessary approximations. The success of those techniques means that they can be applied to problems where the answer is not already known by measurement, such as how particles interact within a supernova.

Perhaps even more important, the ability of science to conquer problems of such difficulty might serve as an example, inspiring the scientists who study matters of sickness, health, life and death to do a little better.

— Tom Siegfried, Editor in Chief

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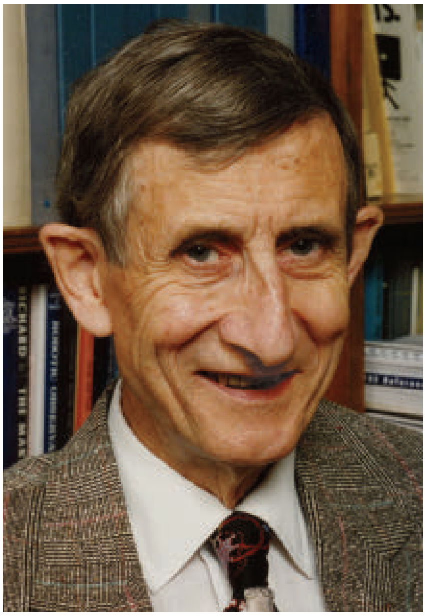

Scientific Observations

"When the first atom was split in 1932, the newspaper man asked Rutherford why he split atoms and Rutherford said, 'Oh, we're like children, we have to take the watch apart to see how it works.' And I think that is absolutely right. That's how it all began.… It was our nature that we just are tinkerers, and then of course it turned out that when you did that with uranium that it fell apart in an even more spectacular way, which we call fission. And as soon as you discovered that, then you knew how to make bombs."

FREEMAN DYSON, IN *WONDERS ARE MANY: THE MAKING OF DOCTOR ATOMIC*, WHICH PREMIERES ON PBS IN DECEMBER

Science Past | DECEMBER 20, 1958

POISON IVY PILLS — A poison ivy pill can offer season-long immunity against America's common summer skin rash.... The standard dosage that will develop immunity

includes one tablet every other day for the first two weeks. This is then followed by one tablet daily for the next two weeks. Then two tablets taken daily for the following two weeks will establish immunity but the two-tablet dosage must be maintained for the remainder of the season to perpetuate immunity for the season.... This means that now, when the family is planning a summer camping trip in the poison ivy or poison oak infested area, children and adults can obtain immunity by beginning the dosage six weeks before the planned trip.

Science Future

December 30
Cleveland's Great Lakes Science Center rings in 2009 with exhibits, films and a balloon drop. Visit www.greatscience.com

January 12, 2009
Smithsonian Institution's 2009 Tropical Extinction Symposium to be held in Washington, D.C. Visit www.si.edu/tec

January 15, 2009
Arp's Atlas of Peculiar Galaxies opens at The Schneider Museum of Art in Ashland, Ore. Visit www.sou.edu/sma

How Bizarre

The University of Michigan's John Hart and his colleagues have shrunk Obama to the nanoscale. Using roughly 150 million carbon nanotubes, the researchers recreated artist Shepard Fairey's poster in their own miniature tribute to the president-elect. See www.nanobama.com for microscope images and for an explanation of how the structures are made.

SN Online
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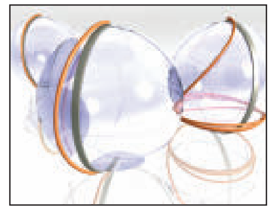
MATTER & ENERGY
MRI works by flipping the magnetic spin axes of atoms back and forth. Faster flipping is possible, which would make for clearer, speedier MRI and perhaps even give quantum computing an extra kick. Read more in "New theory defines faster MRI."



BODY & BRAIN
That gut feeling — it creeps into your bones. A new study suggests that the amount of serotonin made naturally in the gut plays a crucial role in how light or dense bones are. Read more about it in "Bone density may be determined in the gut."

Science Stat

Percent of U.S. patents granted to inventors in 2005 by state

Total patents: 74,637

Top 5

California	24.10
Texas	7.05
New York	6.30
Michigan	4.51
Massachusetts	4.17

Bottom 5

South Dakota	.09
Hawaii	.07
District of Columbia	.07
Wyoming	.07
Alaska	.05

SOURCE: U.S. PATENT AND TRADEMARK OFFICE, SCIENCE AND ENGINEERING INDICATORS 2008

CLOCKWISE FROM TOP LEFT: RANDALL HAGADORN; GWENDAL KERVERN, UNIVERSITY OF LYON, VILLEURBANNE, FRANCE; J. HART, S. TAWFICK, M. DE VOLDER, W. WALKER

“ They had to eat something before people invented wool sweaters. ” — SIBYL BUCHELI, PAGE 12

In the News

STORY ONE

Honeybee CSI: Why dead bodies can’t be found

Virus could explain one symptom of colony collapse

By Susan Milius

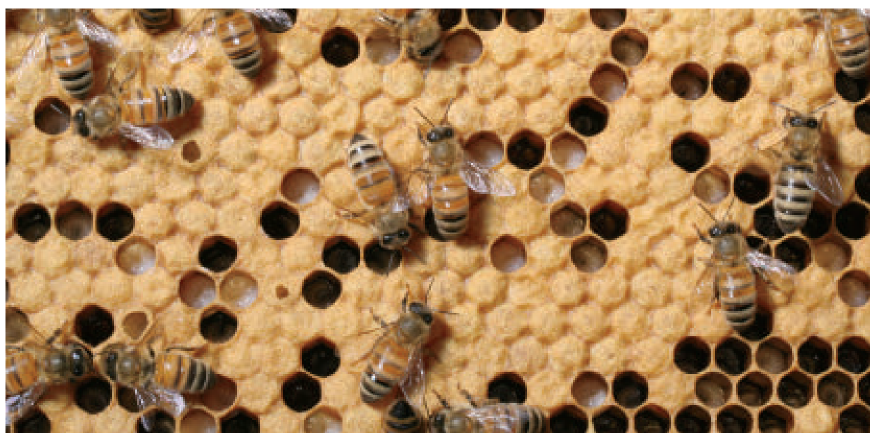
There’s bad news for diehards still arguing that honeybees are getting abducted by aliens.

Beehives across North America continue to lose their workers for reasons not yet understood, a phenomenon called colony collapse disorder. But new tests suggest how a virus nicknamed IAPV might be to blame for one of the more puzzling aspects of the disorder — the impression that substantial numbers of bees vanish into thin air.

In tests on hives in a greenhouse, bees infected with IAPV (short for Israeli acute paralytic virus) rarely died in the hive. Sick bees expired throughout the greenhouse, including near the greenhouse wall, Diana Cox-Foster of Pennsylvania State University in University Park reported November 18 in Reno, Nev., at the annual meeting of the Entomological Society of America.

Outdoors, the bees could scatter across the landscape where the occasional dead insect wouldn’t be easily noticed before scavengers found it.

Illusory alien abduction is just one of many symptoms that need explaining, though. The prevailing hypothesis is that multiple forces combine to cause colony collapse disorder, such as pesticide exposure, parasites and possibly IAPV, Cox-Foster reported.



Healthy hives (top) have worker bees covering most combs, but in hives with colony collapse disorder (bottom), a lot of bees leave the hive and don’t return.

CUSTOM LIFE SCIENCE IMAGES

Viruses belonging to the group including IAPV linger in pollen. Cox-Foster said that she and her colleagues have for the first time isolated bee viruses from pollen samples from outdoor hives, though IAPV itself was not found. In another study, the same viral strains showed up in wild bees and neighboring domestic hives. “Our conclusion is the strains are circulating freely,” Cox-Foster said.

So though the viruses don’t affect mammals and bee products would not be a threat to people, infected bees might contaminate visited flowers, perhaps spreading the alien-abduction symptoms.

Bee scientists first noticed weird bee losses in November 2006 when Pennsylvania beekeeper Dave Hackenberg reported substantial numbers of hives failing for unknown reasons. Honeybees have plenty of reasons to die during winter, but an experienced beekeeper could diagnose the usual ones, so researchers paid attention to Hackenberg. »

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» By mid-December 2006 a team of bee specialists had described the new phenomenon, calling it colony collapse disorder. Colonies otherwise just humming along would lose most of their worker bees in a matter of weeks. The honey, the queen and the very young brood would be largely abandoned without enough of a workforce to tend to them. During that winter, a quarter of beekeepers across the country reported similar disappearances, and 37 percent of U.S. beekeeping operations reported collapses during the following winter.

Roughly a third of food production worldwide depends on animal pollinators such as bees. North American farmers start renting honeybees in February to ensure pollination of the almond crop, and continue renting bees for other crops throughout the growing season. Rental prices for bees are rising, in part because of the collapses. Price changes affect the economics of crops from New England blueberries to Washington state apples.

Even small, stationary operations have been struck by the disorder, said Cox-Foster. "We've had some organic growers report collapses."

Analyses of beekeeping practices dashed notions that some food or treatment to keep pests out of the hives was to blame, she reported. Several studies have failed to find links between colony collapse and acute exposure to crops genetically modified to produce the Bt pesticide.

Jay Evans of the USDA's Bee Research Lab in Beltsville, Md., studies the effects of pathogens on honeybees.

IAPV surfaced as a suspect in September 2007. Researchers at Columbia University and a consortium of other centers and the USDA reported that sequencing DNA from collapsed and healthy hives revealed a high percentage of the once-obscure virus among the sick hives. At the time, researchers cautioned that the virus might be playing a major role or might just be an opportunist, useful as a marker.

In a perfect world, Cox-Foster would have performed the classic experiments based on Koch's postulates: giving a suspected pathogen to an organism, seeing if the disease symptoms match and then trying to recover the same pathogen from the newly ill. Infecting free-flying bees with a potential cause of the disorder wasn't an option, though, so the team experimented in greenhouses.

Those greenhouses stress the bees, says Dennis vanEngelsdorp, Pennsylvania's acting state apiarist. The stress weakens the bees and may contribute to their collapse, he says, agreeing that the virus certainly isn't the whole answer. He points out that IAPV has turned up in colonies that don't collapse, as if they're usually healthy enough to cope with it.

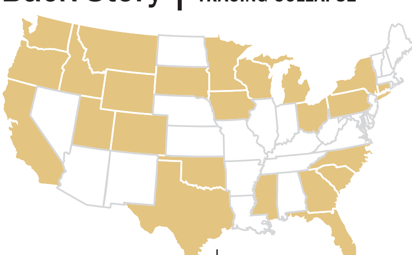
Exposure to conventional pesticides might also affect bee health. Residues of 75 pesticides have turned up in pollen samples, according to ongoing work by Maryann Frazier of Penn State and her colleagues. The pesticide list includes chemicals that are no longer in wide use, such as DDT.

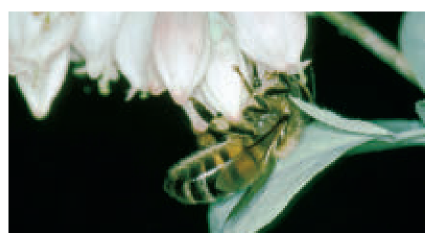
Cox-Foster said in Reno that she was surprised by the range of pesticides found. One sample included residues of the pesticide aldicarb exceeding levels considered toxic for humans, if humans were eating pollen. (Tests of honey show it's safe, Cox-Foster said.) Effects of such cocktails on bees, however, still need clarification.

Despite the new evidence, the pieces of the puzzle aren't falling into a tidy pattern. "I'm not happy about the answer I'm giving you," says vanEngelsdorp. A mix of miseries seems to drive a colony to collapse, but it's not always the same mix.

"It's like heart disease in humans," he says. "Two people can have a heart attack and not share any underlying causes." ■

Back Story | TRACING COLLAPSE





Fall 2006
A beekeeper reports sudden disappearances of worker bees. The poorly understood phenomenon is later called colony collapse disorder.

Winter 2006–07
Some 25 percent of U.S. beekeepers lose at least some hives to the disorder. (Shaded states reported collapses by February '07.)

Spring 2007
The problem isn't a particular food, antibiotic or treatment, researchers report after surveying beekeepers' habits (shown).

Summer 2007
The public and media speculate about far-out causes, including cell phone exposure, alien abduction and bee religious rapture.

Fall 2007
A study in *Science* associates a barely known virus, IAPV, with the disorder, possibly as a contributor or as an opportunist.

Winter 2007–08
About 37 percent of U.S. beekeepers lose some of their colonies. Farmers (including blueberry growers) worry about future pollination.

CLOCKWISE FROM TOP LEFT: USDA-ARS; JERRY A. PAYNE, USDA-ARS/BUGWOOD.ORG; H. PUSCHMANN/ISTOCKPHOTO; MAP SOURCE: BEE ALERT TECHNOLOGY, INC.

For longer versions of these and other Body & Brain stories, visit **www.sciencenews.org**

Boys may show spatial supremacy within a few months after birth

Studies suggest gender gap emerges earlier than expected

By Bruce Bower

The gender gap in spatial abilities emerges within the first few months of life, years earlier than previously thought, psychologists report.

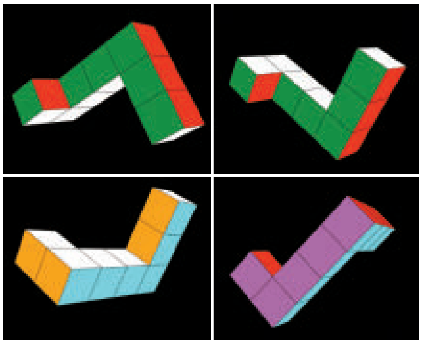
Males typically outperform females on spatial-ability tests by age 4, especially on tasks that require mental rotation of objects perceived as 3-D. Now two studies, which include 3- to 5-month-olds and are published in the November *Psychological Science*, conclude that a much greater proportion of baby boys than baby girls can distinguish a block arrangement from its mirror image, after having first seen the arrangement at a different angle.

The babies who did better on the test are presumed to have mentally rotated the original arrangement and recognized it at its new angle. They chose to gaze at the mirror image the second time around because they perceived it as new.

One investigation was conducted by David Moore of Pitzer College in Claremont, Calif., and Scott Johnson of the University of California, Los Angeles. The other was directed by Paul Quinn of the University of Delaware in Newark and Lynn Liben of Pennsylvania State University in University Park. Both groups suspect that sex differences in mental rotation develop shortly after birth because of an unknown mix of genetic, biological and environmental influences.

"The result we found was really somewhat of a shocker," Moore says. He had expected to demonstrate no sex difference in infants' mental rotation skills, laying the groundwork for pinpointing the age at which this spatial gap first appears.

"Simultaneous reports by two different labs using two different techniques are difficult to dismiss," remarks psychologist Nora Newcombe of Temple University in Philadelphia.



A new study suggests that baby boys are better at recognizing block designs on a new axis than baby girls are.

Still, says Susan Levine of the University of Chicago, the new reports don't confirm that baby boys perform mental rotation tasks better than baby girls do. By 3 months, girls — but not boys — may notice changes in a block arrangement's orientation, Levine proposes. If so, girls would regard both a newly rotated block arrangement and its mirror image as novel, spending roughly equal amounts of time looking at both.

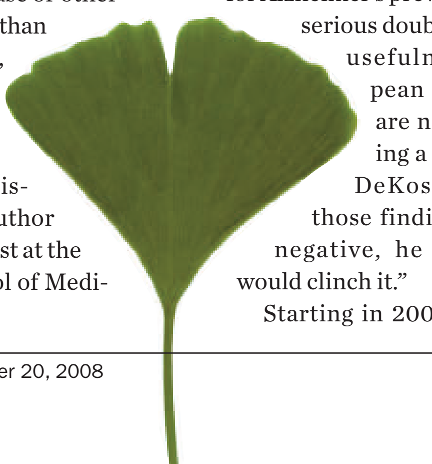
Ginkgo biloba fails drug test

Herb fares no better than placebo against dementia

By Nathan Seppa

The supplement ginkgo biloba has failed to ward off Alzheimer's disease or other forms of dementia any better than a placebo in a long-term trial, researchers report in the Nov. 19 *Journal of the American Medical Association*.

"This is tremendously disappointing," says study coauthor Steven DeKosky, a neurologist at the University of Virginia School of Medicine in Charlottesville.



In earlier lab tests, ginkgo extract showed an ability to protect brain cells from the sort of problems that occur in Alzheimer's patients. In animal tests, the herb inhibited amyloid-beta clumping, widely assumed to play a role in Alzheimer's.

But the new, eight-year study, the largest clinical trial ever specifically designed to test a drug or supplement for Alzheimer's prevention, casts serious doubt on ginkgo's usefulness. European researchers are now conducting a similar trial, DeKosky says. If those findings are also negative, he says, "that would clinch it."

Starting in 2000, DeKosky, then at the University of Pittsburgh, and his colleagues randomly assigned more than 3,000 people, average age 79, to receive two ginkgo pills a day or placebo pills. All participants were free of Alzheimer's disease or other dementia at the start, but some in each group began with some mild cognitive impairment. The researchers tracked the volunteers' progress until 2008.

After an average of six years, roughly equal numbers of people taking ginkgo and people taking placebos had developed dementia, which in the vast majority of cases was Alzheimer's disease.

The study "adds to the substantial body of evidence that *G. biloba* extract as it is generally used does not prevent dementia," writes Lon Schneider of the University of Southern California in Los Angeles in the same issue of *JAMA*.

FROM TOP: ROBERT M. DITTO; RICHCANO/ISTOCKPHOTO

$170 million Average yearly U.S. sales of ginkgo biloba from 2000 to 2004

Sleep makes room for memories by keeping connections flexible

Rest reduces synapse-forming molecules in the brain

By Tina Hesman Saey

WASHINGTON — Sleep not only refreshes the body, it may also push the reset button on the brain, helping the brain stay flexible and ready to learn, new research shows.

Whether it is slow-wave sleep or rapid eye movement, called REM, sleep changes the biochemistry of the brain, and the change is necessary to continue learning new things, suggests research presented November 18 at the annual meeting of the Society for Neuroscience.

Hundreds of genes behave differently when an animal is asleep rather than awake, says Chiara Cirelli of the University of Wisconsin–Madison. Cirelli and her colleagues are trying to settle a long-standing debate about why sleep is necessary. One theory is that sleep helps solidify memories by replaying information learned during the day. Another idea holds that sleep is for energy restoration.

Cirelli and other researchers presented evidence at the neuroscience meeting suggesting that sleep may perform both functions.

In a study in rats, Cirelli and her colleagues discovered that a molecule that works with the brain chemical glutamate becomes more and more abundant the longer rats are awake. The molecule, the glutamate receptor GluR1, helps forge connections, called synapses, between neurons. When rats are awake, the amount of GluR1 in the brain may climb to 40 percent higher than levels found when the animal has been asleep for a few hours.

The team's new study in fruit flies showed that all areas of the brain have much higher levels of synaptic proteins after a fly has been awake awhile. Normally, strengthening a synapse is a good thing. It is one of the steps thought to be important in memory formation. But brains can't continue to build up existing connections forever, Cirelli says.

"We cannot afford to keep growing our synapses one day after another because very soon they would become unsustainable," she says. "Stronger synapses come at a very high price."

It takes a lot of energy, cellular supplies and resources to strengthen the connections. If a neuron puts all of its energy into continually strengthening old synapses, it will never form new ones, making it impossible to learn new things.

Cirelli's group found that sleep breaks down the molecules that form synapses. In particular, slow-wave sleep was important for reducing the number of synapse-forming molecules in the brain. The group also showed in a new study of people that disrupting slow-wave sleep by playing a sound impaired performance on one type of learning task.

> **"Sleep is not only for building things — it's for tearing them down."**
>
> GINA POE
> UNIVERSITY OF MICHIGAN

Disrupting slow-wave sleep may also disrupt REM sleep, says Gina Poe of the University of Michigan in Ann Arbor, so more research is needed to show that slow-wave sleep is the critical stage. But it is clear that sleep is necessary for clearing out old memories to make way for new information, she says.

"Sleep is not only for building things — it's for tearing them down," says Poe. Memories associating names and faces, for instance, are forged first in the hippocampus but are later cleared from that region and stored in other areas, she says.

News Briefs

Treat HIV-positive babies early

Babies infected with HIV from birth should be given powerful drugs to fight the virus as soon as possible, researchers find. In a comparison of treatment strategies, Avy Violari of the University of Witwatersrand in Johannesburg and colleagues report that babies getting medication, even when they are just weeks old, showed dramatically better survival than those treated only after HIV-related symptoms appeared. The study appears in the Nov. 20 *New England Journal of Medicine*. *—Nathan Seppa*

Protein and Parkinson's

Tossing out the old batteries of brain cells might keep those cells strong, new research suggests. Richard Youle of the National Institute of Neurological Disorders and Stroke in Bethesda, Md., and colleagues report online November 24 in the *Journal of Cell Biology* that a protein produced by a gene linked to Parkinson's marks defective mitochondria for destruction while leaving healthy mitochondria untouched. *—Tina Hesman Saey*

Depression hurts the heart

The long-standing connection between depression and heart problems might be traceable to the fact that depressed people are less physically active than others. A greater tendency in depressed people to smoke and to fail to take medications regularly may also play a role, Mary Whooley of the Veterans Affairs Medical Center and the University of California, San Francisco and colleagues report November 26 in the *Journal of the American Medical Association*. *—Nathan Seppa*

Atom & Cosmos

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Mars conceals buried icy treasure

Frozen water reserves discovered in mid-latitude regions

By Ron Cowen

There's ice in them thar hills!

Using radar from an orbiting spacecraft to penetrate the hidden recesses of Mars, planetary prospectors have uncovered vast reserves of water-ice buried beneath rocky debris. The ice resides in hilly sections of the Red Planet's southern and northern mid-latitudes and amounts to the largest reservoir of frozen water outside of Mars' polar regions. The ice could be equal to as much as 10 percent of the volume of frozen water in the planet's polar ice caps.

The concealed deposits, referred to as glaciers because they appear to have inched along the subsurface of the planet in the past, could be a valuable resource for future visitors — supplying drinking water or hydrogen fuel, notes Jack Holt of the University of Texas at Austin. Preserved beneath about 10 meters of dust and rocky debris, the deposits may also provide a pristine record of the Martian climate and atmosphere several hundred million years ago, when these glaciers likely formed.

Holt and colleagues, including Jim Head of Brown University in Providence, R.I., describe the radar evidence for the ice deposits in the Nov. 21 *Science* and in an upcoming *Geophysical Research Letters*.

Numbering in the hundreds, the glaciers could be the remnants of a giant ice sheet that blanketed Mars' mid-latitudes during a past ice age, when climate models suggest the planet was tipped over so that its poles faced the sun and the mid-latitudes were much colder.

The apronlike landforms have intrigued scientists since the structures were spotted by the Viking spacecraft in the 1970s. Lined with ridges and overlapping wrinkles, the aprons are signs that the surface was deformed because of a flow of viscous material — something akin to cold molasses. For decades, researchers assumed that the molasses was created by small pockets of ice that had filled the pores of the surface rocks, lubricating the rocky material and causing it to slowly flow in what geologists call a rock glacier.

The alternative, that the structures might be mostly ice with just a covering of dirt, wasn't on anyone's radar screen, recalls Head. The aprons were far from the poles, and no one imagined that the tilt of Mars' spin axis had varied drastically over the past 10 million years, as later studies showed. Variations in the tilt mean that the poles were warmer in the past. Researchers hypothesize that during that time some of the frozen water at the poles evaporated into the atmosphere and then settled down onto the then-colder mid-latitude regions.

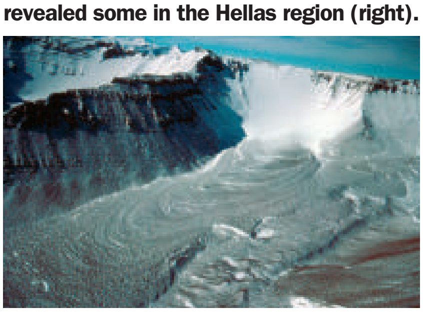
For Head, the clincher was his first foray, a decade ago, to study the dry valleys of Antarctica. These debris-covered glaciers, which abut cliffs and mountains, appeared to be dead ringers for the features on Mars. Now, radar studies with the Mars Reconnaissance Orbiter have confirmed the existence of the Martian covered glaciers, although the size and scale of these differ from Earth's.

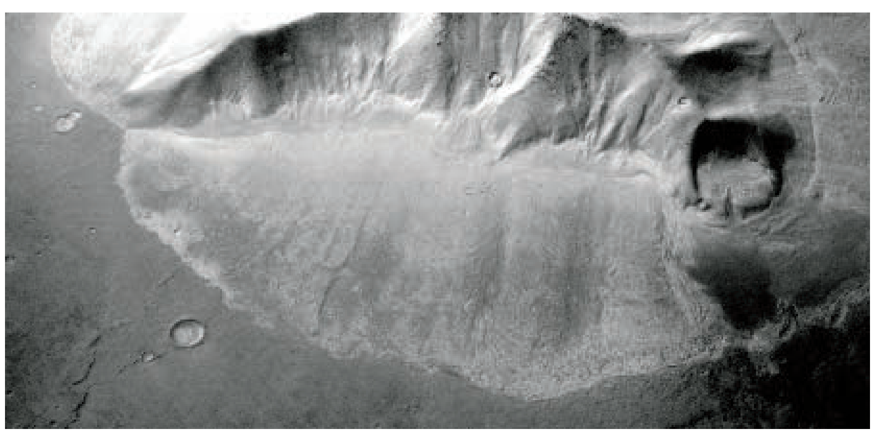
Radar echoes indicated that the radio waves beamed by the orbiter had passed unimpeded through a thin veneer and were then reflected back from a much deeper layer without a significant loss in strength. That would be expected if debris blanketed a thick layer of ice. Holt and colleagues estimate that the buried glaciers are a few hundred meters thick.

The findings "appear to be related to changes in the planet's tilt and orbital parameters in recent epochs, that last a few tens to a few hundreds of millions of years," says planetary scientist Jim Bell of Cornell University.

"It could very well be the case that these subsurface regions need to get added to the list of 'potentially habitable regions' on Mars," he says. Possible sources of localized heat, such as volcanic activity or the impact of space rocks, could melt some of the ice, he notes. "Whether there is anything living down there in places like that either now or in the past ... will no doubt be the subject of intense future debate and exploration," he says.

Covered glaciers in Antarctica (below) inspired researchers to look for buried glaciers on Mars. Radar measurements revealed some in the Hellas region (right).





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Life

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Clothes moths offer forensic clues by building fuzzy, hair-flecked cases

Larvae pick up tresses from corpses to make their homes

By Susan Milius

RENO, Nev. — Clothes moths will eat more than our wardrobe. Given a chance, they'll eat us too.

Casemaking clothes moth caterpillars can digest human hair and will feed on corpses. But it's not all bad news, scientists say. Hair bits nipped off of corpses by *Tinea pellionella* can yield enough DNA to identify the deceased, according to Sibyl Bucheli of Sam Houston State University in Huntsville, Texas.

"It's important to think outside the box," says Jeff Tomberlin of Texas A&M University in College Station. He ranks Bucheli's idea as unusual but credible.

Particularly helpful is the caterpillars' habit of retreating to nearby, out-of-the-way corners when it's time to stop feeding and metamorphose into small tan moths, Bucheli said November 16 at the annual meeting of the Entomological Society of America. The human body they've been feeding on may get moved away, but left-behind caterpillar cases can still tie the body to the location, she said.

A caterpillar of the casemaking clothes moth crawls around in its shelter.

Scientists have discovered clothes moths — one of two major wardrobe attackers in North America — nibbling on corpses before, according to Bucheli. And clothes moth larvae in the wild will graze on dead animals. "They had to eat something before people invented wool sweaters," she said.

This species takes its common name from the half-inch long, skinny, fiber-fuzzed cases that young larvae build. Each youngster surrounds itself with an open-ended case. As caterpillars forage, they stick out their front ends, like chilly campers refusing to climb out of warm sleeping bags.

Bucheli and her colleagues discovered human hair in the cases when a forensics team asked for help with an abandoned body discovered in a Texas house. Investigators asked Bucheli whether the insects around the body offered any clues to when in the past year the person had died. Investigators presented Bucheli with hundreds of insects, including clothes moth larvae in their cases. The parts of the cases made most recently bristled with stubs of human hair.

The hair shafts yielded enough mitochondrial DNA for Bucheli's team to sequence a repetitive bit of genetic material commonly used for forensic identification. To determine the timing, the team relied on the insect assemblage, which lacked some of the species that routinely visit fresh corpses in warm weather. Thus, the person probably had died during cool weather, not in summer as some witnesses had suggested.

Fish that travel together make wiser decisions

When they choose a leader, sticklebacks think as a group

By Laura Sanders

Trial juries, Wikipedia and even *Top Chef* rely on trust in consensus decision making. And in the stickleback fish world, things aren't so different. New research shows that bigger schools are more likely to make good choices, scientists report in the Nov. 25 *Current Biology*.

At the end of the day, members of the species *Gasterosteus aculeatus* have to pick the right fish to follow home. Past research shows that they like fat, evenly colored fish that are healthy and strong.

Ashley Ward of the University of Sydney in Australia and his colleagues set up a situation where fish were forced to choose between a "good" and "bad" leader. Researchers then measured what percentage of fish made the right choice.

Slightly more than half of the live fish tested alone followed healthy-looking replicas of fish. But when the size of the fish group was increased to eight, nearly 80 percent followed the better leader. "The group as a whole is much better at finding the fat fish," says coauthor David Sumpter of Uppsala University in Sweden.

Stickleback fish pick a better leader when they are assembled in a group.

Stephen Pratt of Arizona State University in Tempe says the study offers a different take on the advantages of group living. But before following others off a bridge, he notes, "There's always a danger of amplifying a bad effect."

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Matter & Energy

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Standard model gets right answer

Calculation of nucleon mass supports quark-gluon theory

By Ron Cowen

When it comes to weighty matters, quarks and gluons rule the universe, a new study confirms.

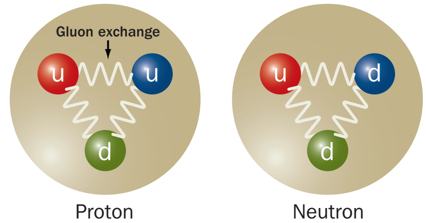
One of the largest computational efforts to calculate the masses of protons and neutrons shows that the standard model of particle physics predicts those masses within 4 percent. Christian Hoelbling of the Bergische Universität Wuppertal in Germany and colleagues report their findings in the Nov. 21 *Science*.

Nearly all the mass of ordinary matter consists of atomic nuclei, composed of neutrons and protons, which in turn are composed of quarks, held together by massless particles called gluons.

Gluons carry the strong nuclear force and are constantly being exchanged by the quarks, as described by the theory known as quantum chromodynamics, or QCD. These exchanges bind quarks together by changing a quark property known as color charge. This charge comes in three different forms, whimsically referred to as red, green and blue. Six different types of quarks interact with eight varieties of gluons to create a panoply of elementary particles.

The new computations confirm a prediction of QCD, part of particle physics' standard model, that the masses of particles such as neutrons and protons come from the energy associated with interactions between quarks and gluons.

In their calculations, Hoelbling and colleagues approximated the continuum of spacetime with a four-dimensional lattice composed of discrete points spaced



New calculations of the mass of protons and neutrons, which consist of quarks and gluons, confirm standard theory.

along columns and rows. The researchers solved the equations of QCD on finer and finer lattices, and then extrapolated the results to the continuum.

"Because these accurate calculations agree with laboratory measurements, we now know, rather than just believe, that the source of mass of everyday matter is QCD," notes Andreas Kronfeld of the Fermi National Accelerator Laboratory in Batavia, Ill., in a commentary accompanying the *Science* article.

In other words, QCD is QED.

Superconductivity does the twist

Electron dance explains loss of resistance in exotic material

By Patrick Barry

Sometimes a twist might be as good as a jiggle. Or at least, a new study suggests, twisting electrons appear to take the place of jiggling ions in an exotic kind of superconductor.

It's the first experiment to show that a type of twisting fluctuations by the material's electrons could explain its superconductivity, scientists report in the Nov. 20 *Nature*. The research also supports a 20-year-old theory about how such twists in electron spin axes could enable superconductivity for some materials.

In superconductors, electric current flows with zero resistance, so a current in a loop of superconducting wire would flow forever even without a power source. Standard superconductors must be kept extremely cold, to almost absolute zero (–273° Celsius). But some materials are superconducting at transition temperatures as high as about –110°C, making them cheaper and more practical.

"This work can probably be a foundation for better understanding high-temperature superconductors and can lead to new forms of unconventional superconductivity," says Tuson Park, coauthor of the study and a condensed matter physicist at Los Alamos National Laboratory in New Mexico.

The mechanism that allows electrons to move unfettered through conventional superconductors is well understood. But unconventional superconductors are still poorly understood. Discovering how such materials work is "the holy grail of superconducting research because only unconventional superconductors can have high transition temperatures," comments Qimiao Si, a condensed matter theorist at Rice University in Houston.

Park and colleagues cooled an exotic material containing the elements cerium, rhodium and indium to near absolute zero, so the material could experience a proposed transition called the local quantum critical point. Around that point, the spin axes of the electrons should begin twisting and fluctuating wildly.

These fluctuations could help electrons to pair up. Only pairs of electrons can move through a superconductor with zero inhibition, but electrons naturally repel each other because they have the same negative electric charge. In conventional superconductors, the jiggling of atomic nuclei in response to the movement of one electron helps another electron to follow closely behind, providing a kind of quantum glue.

"The idea is similar to the conventional except that the glue is different," Park says. Fluctuations in the electron spin axes appear to provide the glue.

A. NANDY

Science & Society

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Many drug trials never published

Results are often biased, incomplete or unavailable

By Rachel Ehrenberg

Patients asking their doctors if a new drug is right for them would do well to also ask for supporting evidence. Conclusions about drug safety and effectiveness in reports submitted to the FDA are sometimes changed in the medical literature to favor the drug, a new analysis finds. And nearly a quarter of submitted drug trials were never published at all, researchers report in the Nov. 25 *PLoS Medicine*.

Information published in journals is accessible to health care professionals and also drives marketing of new drugs. The new study suggests that this information is often incomplete and biased, says health policy expert Lisa Bero of the University of California, San Francisco, who led the study.

An-Wen Chan, who wrote an accompanying commentary but was not involved with the work, says he does not think health care providers will be surprised to learn of suppression and inaccurate reporting of new drug information.

"These new findings confirm our previous suspicions that this is happening on a much broader systemic level. It shows that information is unavailable to those who really need it the most — the clinicians and the researchers," says Chan, of the Mayo Clinic in Rochester, Minn. "If we take the view that research on humans is ethical, is allowed based on an assumption of public good, then all clinical trial information should be publicly available."

Drug manufacturers are required to submit all their studies to the U.S. Food and Drug Administration as part of new drug applications. That's the last step in drug development, following testing on animals, small trials to test safety and larger trials to test effectiveness. Ideally, if the drug receives FDA approval, all the clinical information associated with the drug is made accessible to the public so health care providers can make informed decisions about treatment. This is typically done by publishing in the scientific literature.

The new analysis examined 164 trials for 33 new drugs that were approved by the FDA from January of 2001 to December 2002. By June 2007, 22 percent of the trials were either published only in a partial form — as an abstract, or part of a pooled publication — or were not published at all. The unpublished trials were predominantly those with unfavorable results, the researchers report.

The study could not determine if sponsoring drug companies had prohibited publishing, but some investigators told the research team that they were eager to publish but were unable to coordinate efforts with the drug company.

Development of one drug can require several trials. But among the drugs for which findings were published in the scientific literature, only 52 percent disclosed results from every trial.

Trial outcomes reported in the FDA applications often differed from those reported in the scientific literature. Outcomes are predefined measures that indicate, for example, whether the new drug is more effective than existing treatments, or whether a drug has other effects on a patient's health. In addition to 138 outcomes reported in the new drug applications, journal articles reported 15 more, all favoring the new drug. Only about half of the 43 outcomes in the FDA applications that did not favor the new drugs were reported in the scientific literature. Nine conclusions were actually changed to favor new drugs, the team reports.

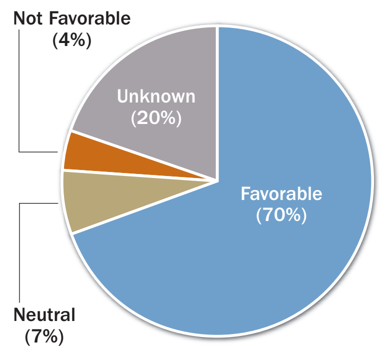
The study highlights the need for full disclosure of all results related to new drugs, says Chan. In fall 2007, a federal law went into effect that mandates registration of all clinical trials in a publicly accessible database, ClinicalTrials.gov, run by the National Institutes of Health. This is a great step forward, says Bero, but there are still holes — safety data, for example, aren't required.

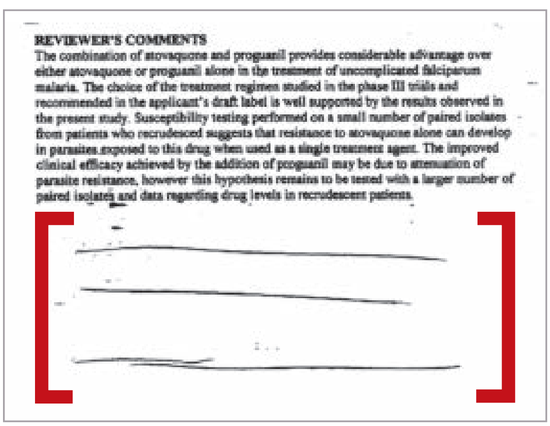
Others have suggested that institutions' review boards, required for drug research done with federal funding, could insist that results be published in full, says John Scoggins of the Fred Hutchinson Cancer Research Center in Seattle.

"The novelty of this article isn't that it reveals publication bias — it's just been hard to find the data to prove it," Scoggins says. "The evidence is just now trickling in of just how bad it is." ■

Results of trials

Of 164 drug trials investigated in a recent study, 70 percent showed favorable results. These were more likely to be published than unfavorable trials.





REVIEWER'S COMMENTS

The combination of atovaquone and proguanil provides considerable advantage over either atovaquone or proguanil alone in the treatment of uncomplicated falciparum malaria. The choice of the treatment regimen studied in the phase III trials and recommended in the applicant's draft label is well supported by the results observed in the present study. Susceptibility testing performed on a small number of paired isolates from patients who recrudesced suggests that resistance to atovaquone alone can develop in parasites exposed to this drug when used as a single treatment agent. The improved clinical efficacy achieved by the addition of proguanil may be due to attenuation of parasite resistance, however this hypothesis remains to be tested with a larger number of paired isolates and data regarding drug levels in recrudescent patients.

Drug data may be redacted from public files, highlighting the need for disclosure in scientific literature.

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Environment

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Antidepressants make for sad fish

Drugs may affect feeding, swimming and mate-attracting

By Janet Raloff

In the fish world, baby is just another word for lunch. So it behooves aquatic larvae to be ever vigilant. But those that as embryos or hatchlings encounter water polluted with trace concentrations of antidepressants are much more likely to become food.

Tons of medicine ends up in the environment each year. Much has been excreted by patients, and leftover pills that have been flushed down the toilet may also contribute. Because water treatment plants weren't designed to remove pharmaceuticals, the water these plants release generally carries an array of drug residues.

In 2006, a pair of chemists reported that antidepressants downstream of water treatment plants were showing up in the brains of fish.

Meghan McGee of St. Cloud State University in Minnesota set out to see if exposure to specific antidepressants would affect larval fathead minnows. Fish exposed as embryos or hatchlings to trace concentrations of the antidepressant venlafaxine, marketed as Effexor, didn't react as quickly as normal to stimuli signaling a possible predator. This laid-back reaction could prove to be a "death sentence," she observes.

McGee's is one of many studies probing behavioral impacts on aquatic wildlife from pharmaceutical pollution. Emerging data were reported November 16–20 at the North America annual meeting of the Society of Environmental Toxicology and Chemistry. Overall, the studies show that antidepressants can impair a fish's ability to eat, to avoid being eaten — and perhaps to attract a mate.

"I was surprised how often I was seeing these antidepressants," recalls Melissa Schultz of the College of Wooster in Ohio, one of the chemists who documented that antidepressants reach fish brains. "Pretty much any water sample in the vicinity of a wastewater treatment plant will test positive for some group of antidepressants."

The St. Cloud State results wouldn't be so bad if predators were also slowed by these similarly low concentrations. But such nanogram concentrations of fluoxetine, marketed as Prozac, didn't slow the speed at which hybrid striped bass scarf down fathead minnows, according to preliminary data reported by Joseph Bisesi Jr. of Clemson University in Pendleton, S.C., and his colleagues. Only at higher concentrations did some of the aggressive bass start to lose their voracious appetites.

Heiko Schoenfuss, leader of the St. Cloud study, also reported that fluoxetine functions like estrogen in the minnows and can diminish the facial bumps and coloration that females prize in mates.

Of course, all these experiments are quite artificial. Schultz says that a fish exposed to wastewater gets a dose of a lot of other things. "We'll have to look at how these might all interact," she says.

CLEMSON UNIVERSITY'S INSTITUTE OF ENVIRONMENTAL TOXICOLOGY

Some hybrid striped bass exposed to Prozac stopped eating and began hanging vertically in the water.

Meeting Notes

Algae's feminine touch

Yoshifumi Hida and colleagues at the University of Shiga Prefecture in Japan report isolating "natural estrogens" produced by single-celled *Chlorella* algae in a freshwater pond. In lab tests, these primarily female sex hormones sped ovary maturation and inhibited the development of testes in carp. —*Janet Raloff*

Chicago's hot new PCB

Decades after U.S. production of polychlorinated biphenyls ended, a van-mounted device sampling air pollution outside Chicago schools turned up PCB-11. Previously linked to yellow-paint production, this PCB had never been seen tainting air. Keri Hornbuckle of the University of Iowa in Iowa City and colleagues report that PCB-11 tainted 90 percent of the city's air samples, and there were notable hot spots. Overall, this pollutant — perhaps released by old paint — proved Chicago's sixth most abundant airborne PCB. —*Janet Raloff*

Pollution slows some sperm

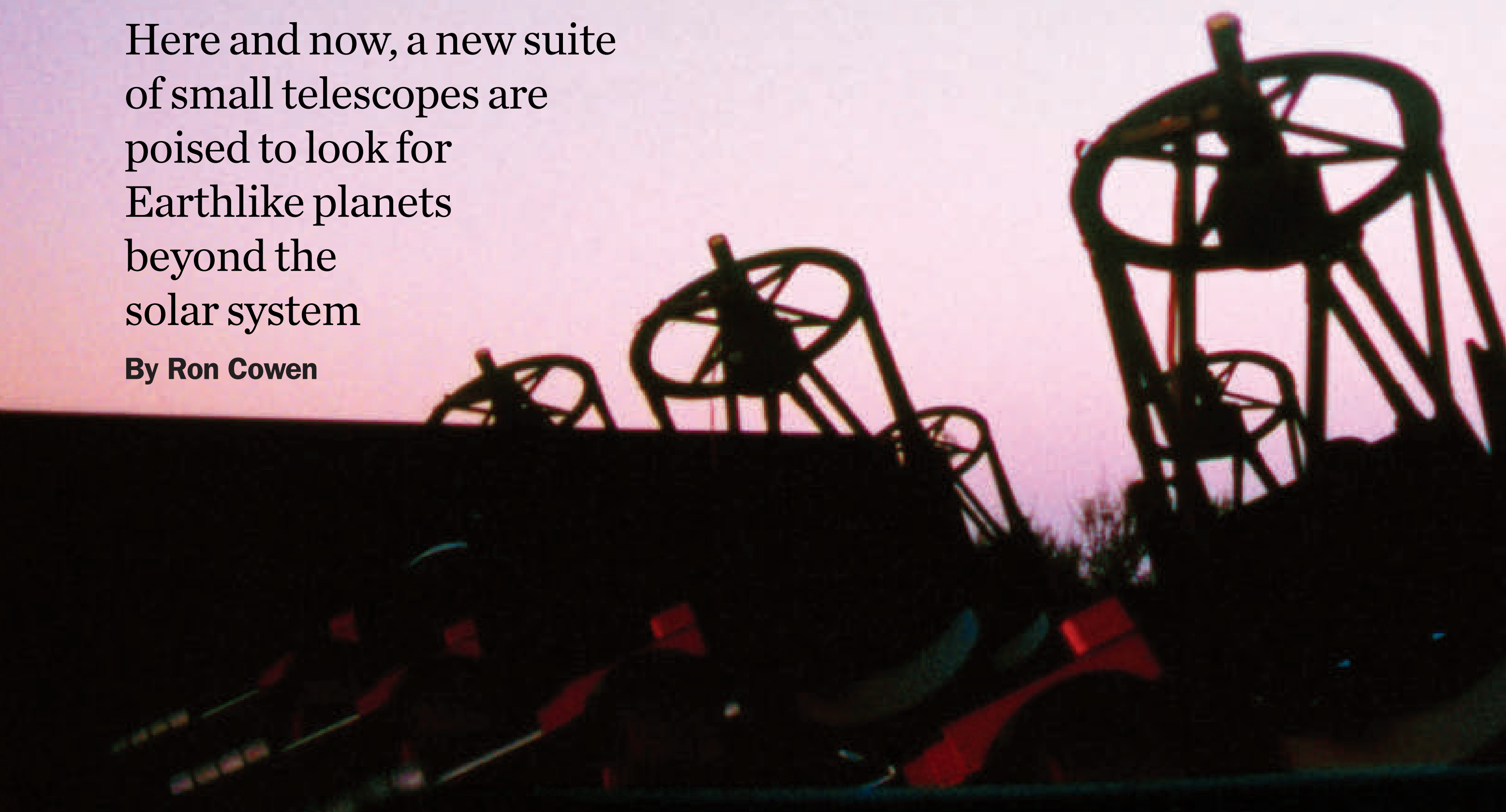
Many marine species broadcast eggs and sperm into the water, hoping they meet and beget another generation. In this environment, "sperm are often the limiting factor," notes Ceri Lewis of the University of Exeter in England. Her data from two polychaete worms and a mussel indicate coastal concentrations of some common pollutants — several fuel-related hydrocarbons and the metals cadmium and copper — can slow and damage sperm. Diminished egg fertilization was "essentially equivalent to halving the number of sperm available," the ecotoxicologist reports. —*Janet Raloff*

The Hunt for Habitable Planets

Here and now, a new suite of small telescopes are poised to look for Earthlike planets beyond the solar system

By Ron Cowen

For years, planet hunters have been preoccupied with hot Jupiters — giant, gaseous planets that tightly hug their sunlike parent stars. These massive, close-in planets, not yet directly seen, are the easiest to find because they induce the largest wobble in the motion of the stars they orbit. But now astronomers are following a rockier road — seeking rocky, icy planets only a few times as massive as Earth. Soon, astronomers predict, they will discover an Earth-sized planet that orbits within the habitable zone of its parent star. And if David Charbonneau has any say about it, that historic find will come from eight tiny telescopes his team has just finished assembling at the Fred Lawrence Whipple Observatory on Mount Hopkins in Arizona.



The telescopes, each only 40 centimeters in diameter, are designed to scan the 2,000 closest small, low-mass stars in the northern skies. The telescopes will look for signs that an orbiting planet periodically passes between the star and Earth, blocking a tiny but detectable amount of starlight every pass, or transit.

Nine years ago, Charbonneau, now at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., and his then adviser, Tim Brown of the National Center for Atmospheric Research's High Altitude Observatory in Boulder, Colo., pioneered the transit method of hunting planets. The technique offers a key advantage over the wobble method, which reveals both transiting and nontransiting planets but provides only their minimum mass and the time it takes to orbit.

By measuring the precise amount of light obscured by a passing planet, transit studies reveal the planet's size. When combined with the wobble data, transits also indicate a planet's true mass. In addition, the starlight filtering through the atmosphere of a transiting planet, like a flashlight shining through a fog, reveals the composition of gases clinging to these alien orbs — even though the planet itself would lie too close to the glare of its star to be imaged.

Before the discovery of the first transiting planet, HD 209458b, in 1999 "no one appreciated that these sorts of studies would be the ones" that would first provide information on a planet's composition, notes Charbonneau. "I don't think people understood at the time or really realized … this would allow you to directly detect light from the planet without having to take its picture." Eventually, scientists from all over the world embraced the strategy.

For the first few years, Charbonneau and his collaborators, along with a slew of other astronomers, limited their search for transiting planets to relatively large, sunlike stars. An orbiting planet has a higher probability of making a transit, as viewed from Earth, when the body lies close to its parent star. And in order to block enough light from a big star to be detected, the transiting planet must also be relatively large. So the transiting objects researchers initially found were all giant, star-hugging planets — the hot Jupiters.

But around 2005, Charbonneau got another idea. If he could look for transits around an abundant group of dwarf stars, called M stars or M dwarfs, which are only about one-third the mass of the sun and smaller in size, he could find planets as small as twice Earth's diameter. "M stars are so small that you really could detect something as small as a superEarth — a planet five to 10 Earth masses — orbiting them if the planet passed in front," says Charbonneau.

Then he took another leap. Instead of just looking for a rocky planet not much bigger than Earth, he thought, "what about going for the big kahuna — habitability?" Because M stars emit much less heat and light than sunlike stars, a planet closely orbiting one of these dwarfs might still lie in the habitable zone, where water would remain liquid. So not only could Charbonneau hope to find small planets, but also ones that might be capable of supporting life.

Calculations by Charbonneau and Philip Nutzman of Harvard-Smithsonian revealed that such a search would require telescopes with mirrors four times bigger than the 10-centimeter instruments used to find transiting Jupiters. Luckily,

The eight small telescopes that make up the MEarth project at the Whipple Observatory sit atop Mount Hopkins in Arizona. The telescopes seek habitable, rocky planets around M stars.

JONATHAN IRWIN/HARVARD

Charbonneau says, 40-centimeter telescopes are large, but still within the limit of what's commercially available, without the need for years of special design and ordering.

Armed with an unexpected windfall — funds from a Packard Fellowship for Science and Engineering — Charbonneau's team put the plan into action. This fall, the team installed the last three telescopes in the eight-telescope facility that Charbonneau calls MEarth (for transiting Earthlike planets around M stars) and has now begun hunting for habitable planets, he reported in October in Ithaca, N.Y., at the annual meeting of the American Astronomical Society's Division for Planetary Sciences.

"This is the single greatest opportunity" in extrasolar planet studies, Charbonneau says, "because you can detect these planets from the ground and you can study them with Hubble's successor, the James Webb Space Telescope, which is already being built."

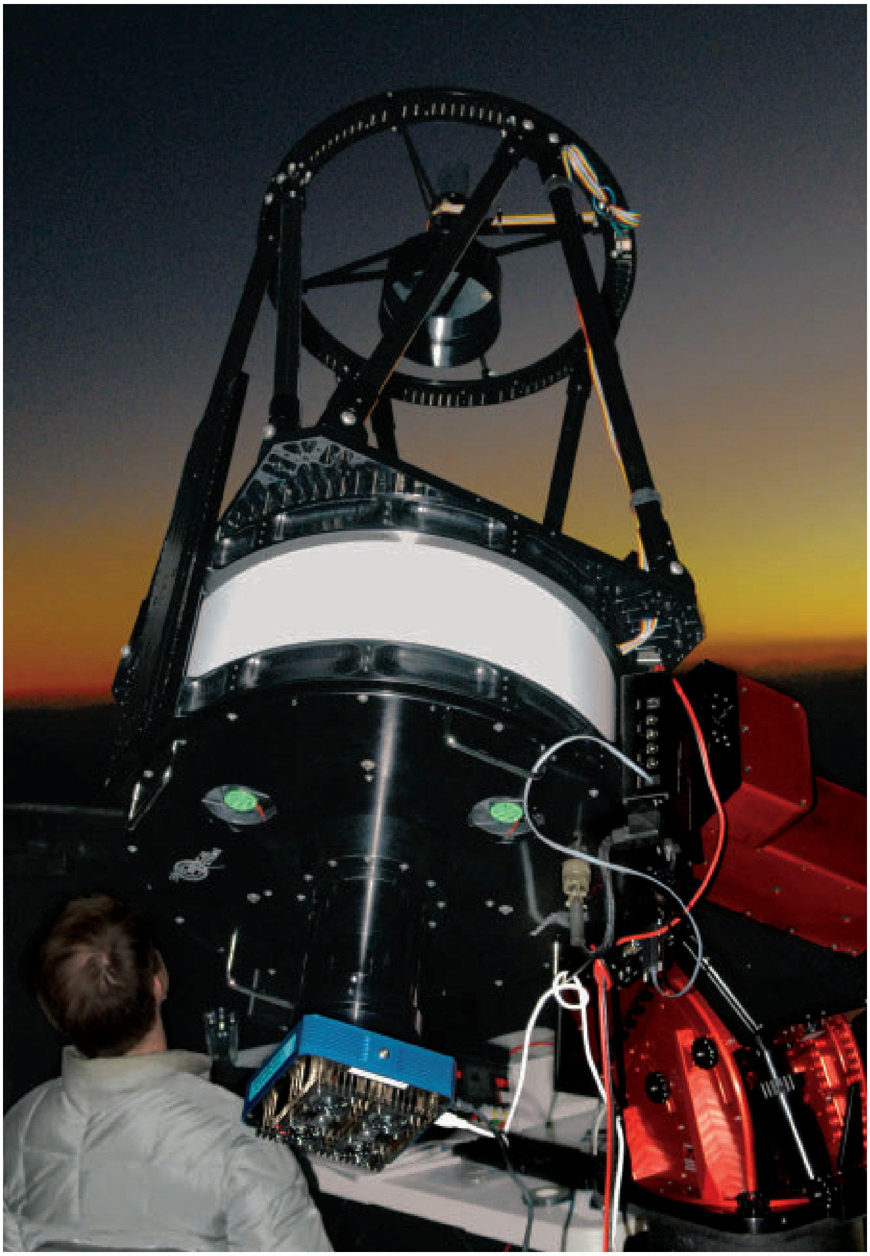
Theorist Sara Seager of MIT says MEarth is a good idea. She likens it to hunting for a lost item under the first available streetlight. The item may not lie under the streetlight, but it's the easiest place to start looking. Ultimately, she notes, "we want to find Earth analogs around a sunlike star, but it's easier to find such planets around small stars than it is to find a small planet around a big star."

The hunt begins

Most planet transit surveys stare at a single patch of sky, using visible light to look for transits around stars in that patch. In contrast, MEarth will track 2,000 M stars all over the Northern Hemisphere at infrared wavelengths only slightly longer than those of visible light — ranging from 700 to 1,000 nanometers — and will eyeball a few hundred of the bodies every night as they drift across the sky. Each of the eight robotic telescopes will monitor an individual M star, which is brightest at infrared wavelengths, every 20 minutes, the time needed to catch a close-in planet's transit, which might last only an hour. If one of the telescopes finds a star that undergoes periodic dimming — a possible transit — it will trigger the other seven to track the same star.

Once a transit is identified, the star must still be observed by telescopes other than MEarth. These would carefully monitor the star's speed, confirming that the body is truly being pulled to and fro by an orbiting planet. Combining data from these observations could provide more details about the planet, including its mass, radius and whether it is dense enough to be rocky or puffy enough to be gaseous.

To look for possible signs of life — the presence, for instance, of ozone in the transiting planet's atmosphere — astronomers will have to wait until 2013, when the James Webb Space Telescope is set for launch. Only JWST, with its large, 6.5-meter mirror flying above Earth's



BRAD EHRHORN

A close-up of one of the MEarth telescopes. MEarth is the first project devoted to finding habitable, rocky planets. Each telescope will scan a few hundred M stars nightly for such orbs.

turbulent atmosphere, will collect enough photons to record the faint spectra of an M star's light filtering through the atmosphere of a small, rocky planet, Charbonneau says.

Even with the capabilities of the orbiting observatory, taking those measurements will still be extraordinarily difficult, notes theorist Tom Greene of NASA's Ames Research Center in Moffett Field, Calif. That's because the atmospheres of terrestrial planets are small and thin compared with the sizes of the stars they transit. Within those small atmospheres, the region in which a molecule like water would strongly absorb starlight is even tinier, only one-two-hundredth the area of the planet's atmosphere. So even for a terrestrial planet transiting a very bright, nearby M star, obtaining spectra would require some 50 hours of observations with JWST, Greene says. Trying to study the composition of a more massive solid planet, a superEarth, may be even harder because the larger gravitational tug of these orbs shrinks the size and area of their atmosphere, he adds.

Only a handful of the 2,000 stars surveyed by MEarth may harbor a transiting habitable planet. (The number of habitable planets around M stars that don't happen to transit might be 10 times that number.) But the survey, he says, will also help answer other questions.

"In our solar system, the biggest rocky planet is Earth," notes Charbonneau. "We want to find out why we don't have a [rocky] friend that's three times the mass of Earth, why the next heaviest planets are the ice giants," Uranus and Neptune.

A decade ago, when researchers first examined the diversity of Jupiter-like planets, it was shocking, recalls Charbonneau. "We expected to find gas giants in circular orbits with 12-year periods, just like Jupiter." Instead, most whipped about their stars in just a few days, orbiting within roasting distance.

"We now want to explore the diversity of rocky [and icy] planets just as we have explored the diversity of giant planets like Jupiter," Charbonneau says.

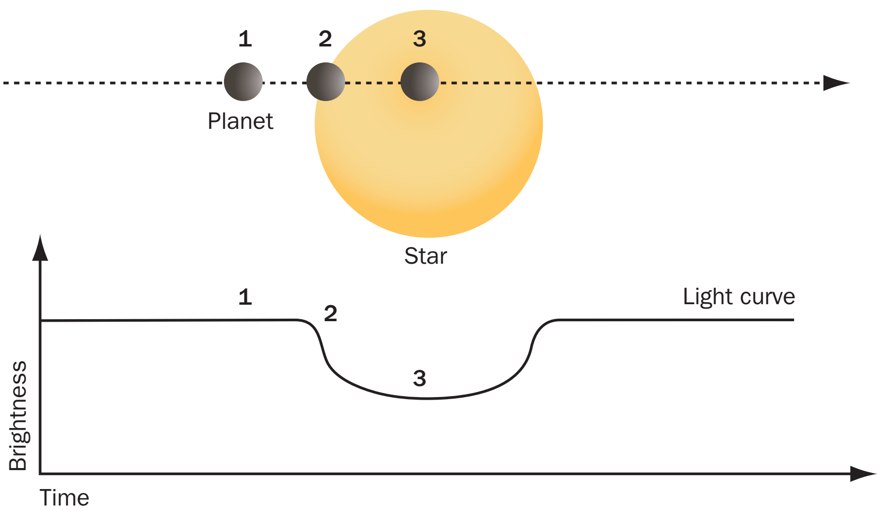
Measuring the mass and radius of a terrestrial planet reveals a planet's average density, and that in turn may indicate where the body formed. For instance, a close-in planet with a low density, suggesting a mixed composition of rock and ice, is likely to have migrated from a spot farther from the star, where a reservoir of icy material once resided.

While MEarth won't find nearly enough rocky planets to do a complete census, "all we want to do is open the door" to exploring the nature of the first few terrestrial planets, he says.

Other teams, including a group of planet hunters led by Michel Mayor of Geneva Observatory in Sauverny, Switzerland, have adopted a different approach for seeking habitable planets. Rather than looking for transits among a large group of stars, many of which aren't likely to have a planet in the first place, they first use the wobble method to winnow down the sample. Only stars whose back-and-forth motion indicates the presence of an orbiting planet are closely examined for a periodic dip in brightness — the telltale sign of a transiting planet. There's a 50-50 chance that this approach may yield the first

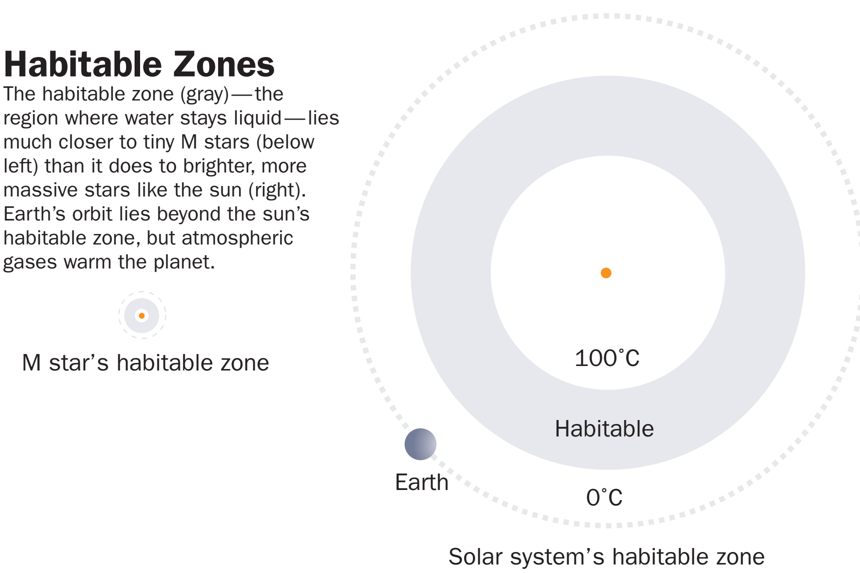
In Transit

A planet (1–3) crosses in front of its parent star, creating a mini-eclipse that blocks a small amount of starlight from reaching Earth.



Habitable Zones

The habitable zone (gray) — the region where water stays liquid — lies much closer to tiny M stars (below left) than it does to brighter, more massive stars like the sun (right). Earth's orbit lies beyond the sun's habitable zone, but atmospheric gases warm the planet.



FROM TOP: ESA; SOURCE: CHARBONNEAU *ET AL.*

habitable, transiting planet around an M star, says MIT's Seager.

Caveats for the hunt

While M stars offer some distinct advantages for finding terrestrial planets, some of the stars' quirks might not bode well for finding those bodies that support life, theorists caution.

"We're really excited about M stars, but there are a lot of reasons not to like them," Seager says. For instance, M stars are active for most of their long lives, with strong magnetic fields that can trigger flares and hurl parcels of gas into space. These flares are similar to the solar outbursts known as coronal mass ejections, in which the sun explosively ejects billion-ton clouds of charged particles.

In addition, although M stars overall emit much less radiation than the sun, they radiate copious amounts of extreme ultraviolet light. Both the radiation and outbursts could erode the atmosphere of a close-in terrestrial planet, and without the protection of an atmosphere, life similar to that on Earth may not be possible.

Another factor, separate from the M star questions, is that MEarth can look only for planets twice Earth's size or several times heavier. A terrestrial planet even a few times more massive than Earth is more likely to have an entirely solid core, rather than a liquid outer core surrounding a solid center, says Seager. The churning of material within a liquid outer core is believed to be a prerequisite for generating a planet's magnetic field. Without a magnetic field acting as a shield, harmful cosmic rays and other charged particles are more likely to hit the planet.

Theorist Jack Lissauer of NASA-Ames has similar concerns. Because an M star's habitable zone lies so close to the star, a planet residing there could be particularly vulnerable to the vicissitudes of its parent, such as a sudden outburst. In addition, a planet twice the size of Earth could be 12 to 15 times as massive, he says, and it's unclear exactly how Earth-like such a planet could be. The interior of such a body could be extremely hot, he notes.

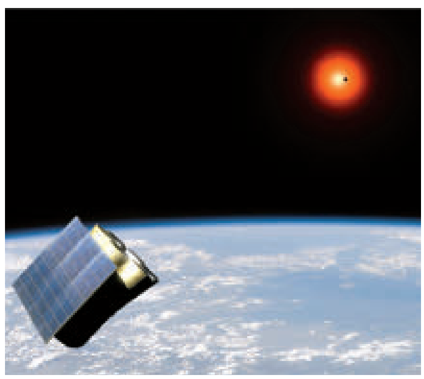
Charbonneau says he agrees that the strong magnetic fields of M dwarfs can lead to increased ultraviolet emission and activity. But, he adds, "While we can ponder what the effect of all this would be on the evolution of life on the planet's surface — it could be harmful, but then again it could promote random mutations — we have absolutely no hard evidence as to what the actual effect will be.

"My goal is very much to learn about the robustness of life in different stellar environments. If we find planets in the habitable zones of low-mass stars, and determine that these planets have all the right building blocks for life — for example that they are rocky, are at room temperature and have liquid water — but find no life upon them, that would be a very interesting result indeed." ■

Other searches, other transits

MEarth isn't the only set of instruments scanning the skies for the transit of rocky planets around nearby stars. COROT, a French-European Space Agency mission launched in December 2006, has a single, 30-centimeter telescope that stares at two much smaller patches of sky but for a much longer time than MEarth. Astronomers calculate that by the end of its 60,000-star survey next year, COROT will find 10 to 40 transiting rocky planets. Each of these rocky orbs, dubbed superEarths, would have a diameter several times that of Earth. COROT will also detect dozens of previously unknown gas giants, ESA scientists predict.

Every 150 days, COROT rotates by 180 degrees and switches observations from one patch of sky to an oppositely located region. The observatory focuses on transiting planets of sunlike stars, rather than the low-mass M stars in the MEarth mission. Although these planets lie too close to their massive and hot parent stars to be habitable, COROT will provide a better census of how common super-Earths are in the Milky Way galaxy.



The proposed TESS telescope

SEAGER *ET AL.*

NASA's more comprehensive Kepler Mission, scheduled for launch next March, will examine 100,000 stars over three and a half years, finding planets as small as half the size of Earth. With its 0.95-meter mirror, the satellite "has the ability to find actual, honest-to-God analogs of the sun-Earth system," says David Charbonneau of the Harvard-Smithsonian Center for Astrophysics. Follow-up studies will be tricky. Even the James Webb Space Telescope won't have the collecting area to analyze the feeble amount of starlight filtering through the atmospheres of these planets. But Kepler will answer an enduring cosmic riddle — whether planet Earth is an oddball in the pantheon of planetary systems or just another face in the crowd.

A proposed space mission by MIT's Sara Seager and her colleagues, the Transiting Exoplanet Survey Satellite, or TESS, would use six wide-field cameras to search for dips in brightness among as many as 100,000 M stars during its two-year mission. TESS would examine a much larger group of M stars for transiting, habitable planets and would have the potential to discover several hundred of them. Because these stars would be nearby, bright systems, it would be relatively easy for JWST to study the planets' atmospheres, notes Charbonneau. If NASA decides to fund the mission, it could be ready for launch in 2013, Seager says. — *Ron Cowen*

Explore more

- Details of the MEarth project appear at arxiv.org/abs/0807.1316

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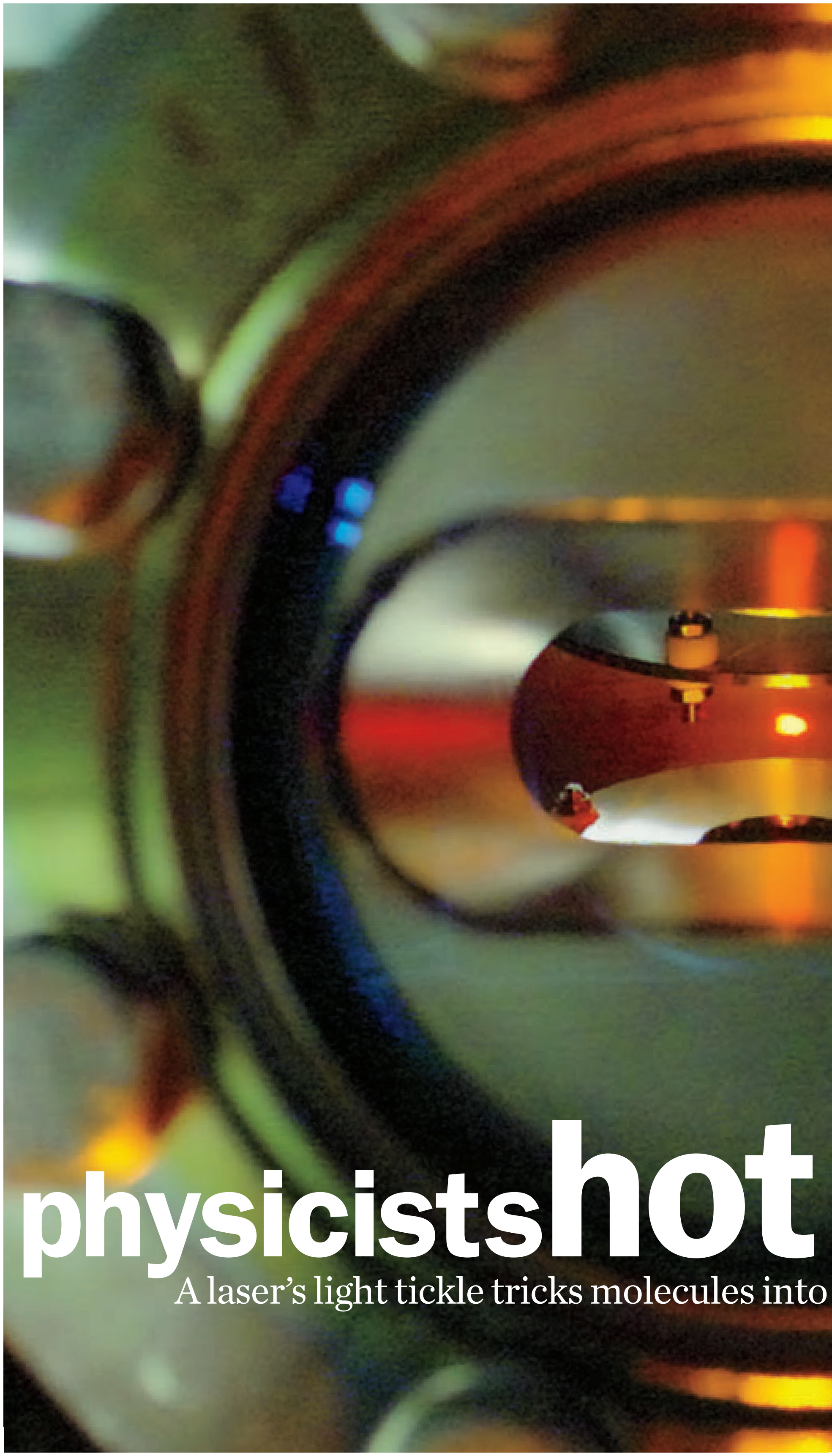


physicists hot

A laser's light tickle tricks molecules into

Molecules are hot. They zip, spin and vibrate with frenetic motion. They jiggle and twist on the inside and bounce on the outside, imparting structure and physical properties to nearly everything that exists. But by achieving temperatures colder than any in the natural world, physicists can almost stop these speed demons cold.

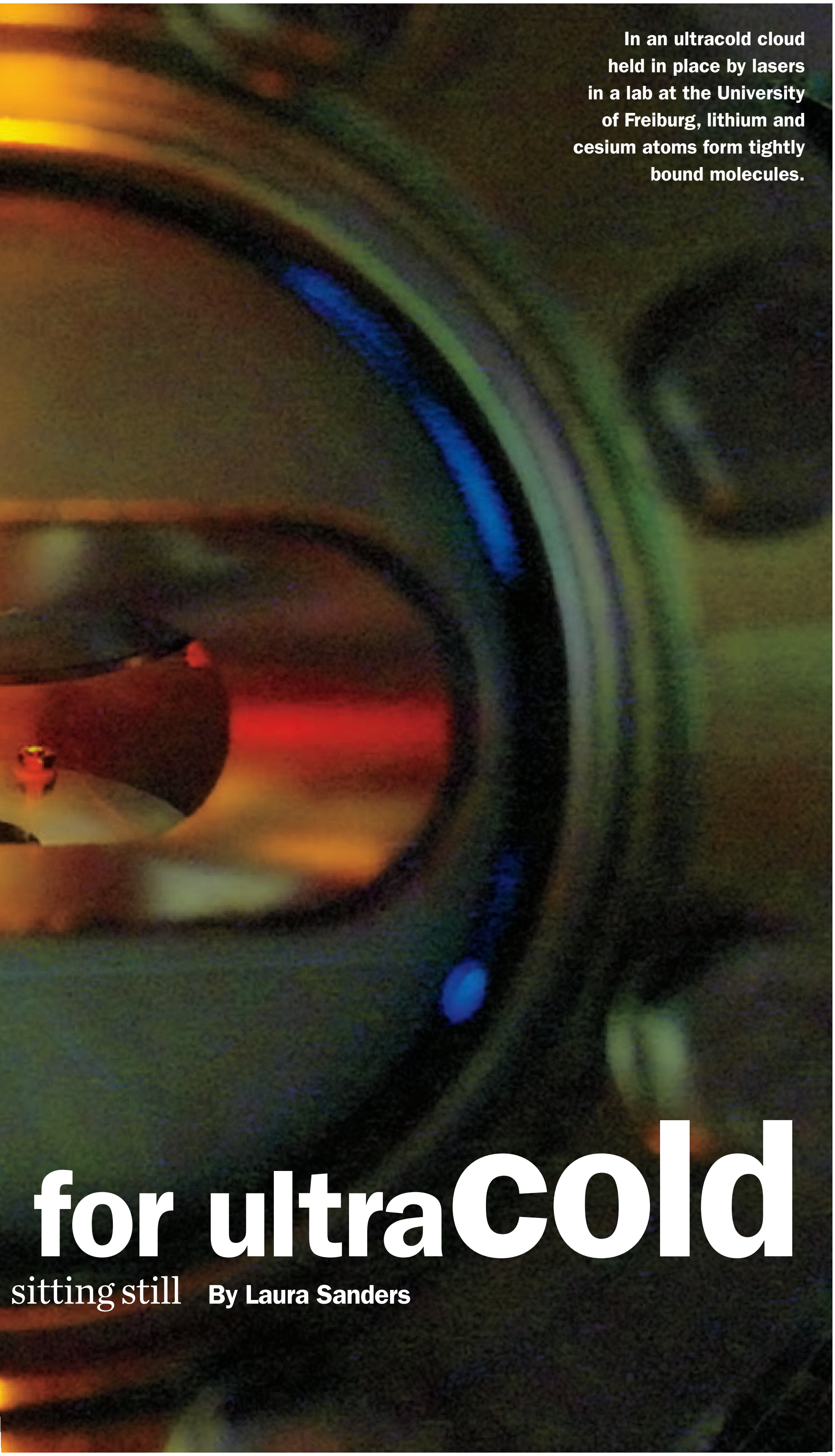
Like surgeons who slow a beating heart by packing ice around a patient's chest, physicists have recently coaxed molecules into ultracold states in which motion is nearly gone. Researchers are left with intriguing, exquisitely controllable new specimens to poke and prod, enabling experiments that would be impossible with everyday hot molecules that rotate and vibrate at their usual frenzied pace.

To still these jittery molecules, temperatures must descend to about 350 nanokelvins, only a sliver above absolute zero and far colder even than the depths of outer space (about 3 kelvins, roughly 300 degrees Celsius colder than room temperature).

Researchers have now figured out ways to reach such lows, using precise laser pulses to trick molecules into giving up energy in the form of light. As the temperature drops, energy is siphoned away from the molecules. These new experiments have created a large, stable supply of ultracold molecules stationary enough to operate on.

"This is the breakthrough," says Matthias Weidemüller, a physicist who was formerly at the University of Freiburg in Germany and whose group recently succeeded in making an ultracold lithium-cesium molecule. "The thing that drives the whole field is to create ultracold systems that you can manipulate and observe."

What motivates the scientists is the potential of ultracold molecules as new tools for research. Such tools could help answer questions about the relationship between individual molecules as they collide: Cold chemical reactions are so slow that physicists have enough time to catch nuances of the interac-



In an ultracold cloud held in place by lasers in a lab at the University of Freiburg, lithium and cesium atoms form tightly bound molecules.

JOHANNES DEIGLMAYR

for ultracold

sitting still **By Laura Sanders**

tions between molecules. Researchers could harness lattices of trapped, frozen molecules to explore the application of quantum mechanics to data storage and transmission. And more fundamentally, ultracold molecules may enable physicists to discover new, exotic phases of matter, such as a kind of superfluid in which molecules act across long ranges to influence one another in a frictionless system.

A new abundant supply of ultracold molecules has bumped physicists into their own excited state of high energy. “There is an awful lot of detail and rich physics to explore,” says Paul Julienne, a theoretical physicist at the National Institute of Standards and Technology in Gaithersburg, Md.

The jittery molecule

Molecules, unlike the spherical atoms that compose them, are lumpy. Physicist Jun Ye says atoms are basketballs, and molecules American footballs. Two basketballs bounce off each other in a predictable way, says Ye, of the University of Colorado at Boulder. But molecules have awkward angles and unwieldy curves, making interactions less predictable.

“Atoms are easier to control,” says Ye. “Molecules are more complex, and more exciting to study than atoms.”

Physicists have been able to freeze atoms using laser light for years. But molecules — which come in a wide variety of shapes, sizes and charges — have proved to be a greater challenge. “The techniques to ultracool atoms can’t be used for molecules,” says Weidemüller, who is now at Heidelberg University. “That’s why one had to come up with a good trick to make them slow.”

Physicists had identified two approaches for creating ultracold molecules: Hot molecules could be cooled, or already cold atoms could be cajoled into joining.

Attempts by several groups started with hot molecules, but that approach proved extremely difficult. While several experiments resulted in a few weakly bound cold molecules, the molecules weren't cold enough. They were cold on the outside but hot on the inside; they were "vibrating like hell," says Weidemüller.

The second way — using lasers to coax already cold atoms to link up into molecules — worked better. "No one's been able to laser-cool a molecule, but recently, people have been able to stitch together two cold atoms," explains Julienne, who, along with Ye, created ultracold potassium-rubidium molecules.

Some labs, including Ye's in Colorado and Weidemüller's in Germany, used a magnetic field to first coax the ultracold atoms into loosely bound molecules. These proved to be the crucial starting material for ultimately taming the internal molecular motion. But, because the atoms were so far apart, the molecules weren't stable. At the slightest provocation, they would fall apart into individual atoms. Physicists needed a way to make these "fluffy" ultracold molecules denser. The cold atoms needed to hold hands, not shout hello to each other from across the football field.

Minding the energy gap

During the transition from weakly bound — when the two atoms are loosely linked and still vibrating internally with energy — to a tightly bound molecule in its ground state, a lot of energy is released. The challenge is to remove that energy without generating any heat. Bonds between the atoms in these loose molecules are already as far apart as possible, so even a small amount of heat could push the atoms over the edge, sending them whizzing away from each other.

Ye says dropping the energy level from that of the loosely bound molecules to tightly bound ones without heating up the system is analogous to hiking from the top of the Grand Canyon down to the Colorado River without producing a drop of sweat. "This is a huge energy space to traverse," Ye says. His team sprinted down to the bottom without perspiring, and published the results in the Oct. 10 *Science*.

Around the same time, other research teams also successfully created different types of stable ultracold molecules. Weidemüller's group created molecules made of an atom of lithium and one of cesium, similar to Ye's diatomic molecule of potassium and rubidium. Other groups created molecules composed of two atoms of cesium and molecules of two atoms of rubidium. And yet another group managed to make an ultracold molecular plasma — a form of matter with free-flowing electrons — from nitric oxide molecules. While the exact methods differed, the teams' approaches are complementary, Weidemüller says, and largely based on laser technology.

For Ye's energetically traveling molecules, all of the extra energy was taken away by photons — single packets of light — delivered by lasers. After painstaking experiments and calculations to figure out how much energy these ultracold molecules held, physicists knew exactly how much energy needed to be sapped and what wavelength of laser light would do the job. The first laser hit the loose molecules with a photon of light at exactly the right wavelength to excite the molecule into an intermediate high-energy state. Then the second laser pulse, of a different wavelength, caused energy to leave the molecule, dropping the molecule down into the lowest possible energy state. At this point, the two atoms locked together in a tightly linked molecule.

Physicists had previously been unable to get enough molecules into this stable and still ground state. Ye's group managed to transform more than half of the loosely bound molecules into tight, stable molecules, creating a rich starting material that can be used to answer all sorts of new questions.

"It's really a new frontier," says Wolfgang Ketterle, a physicist at MIT who shared the physics Nobel Prize in 2001 for pioneering research on ultracold atoms.

> **"This is the breakthrough.… The thing that drives the whole field is to create ultracold systems that you can manipulate and observe."**
>
> MATTHIAS WEIDEMÜLLER
> HEIDELBERG UNIVERSITY

The ultracold world

For many researchers, the ultracold frontier will be dominated by molecules made of two kinds of atoms, such as the lithium-cesium and potassium-rubidium molecules.

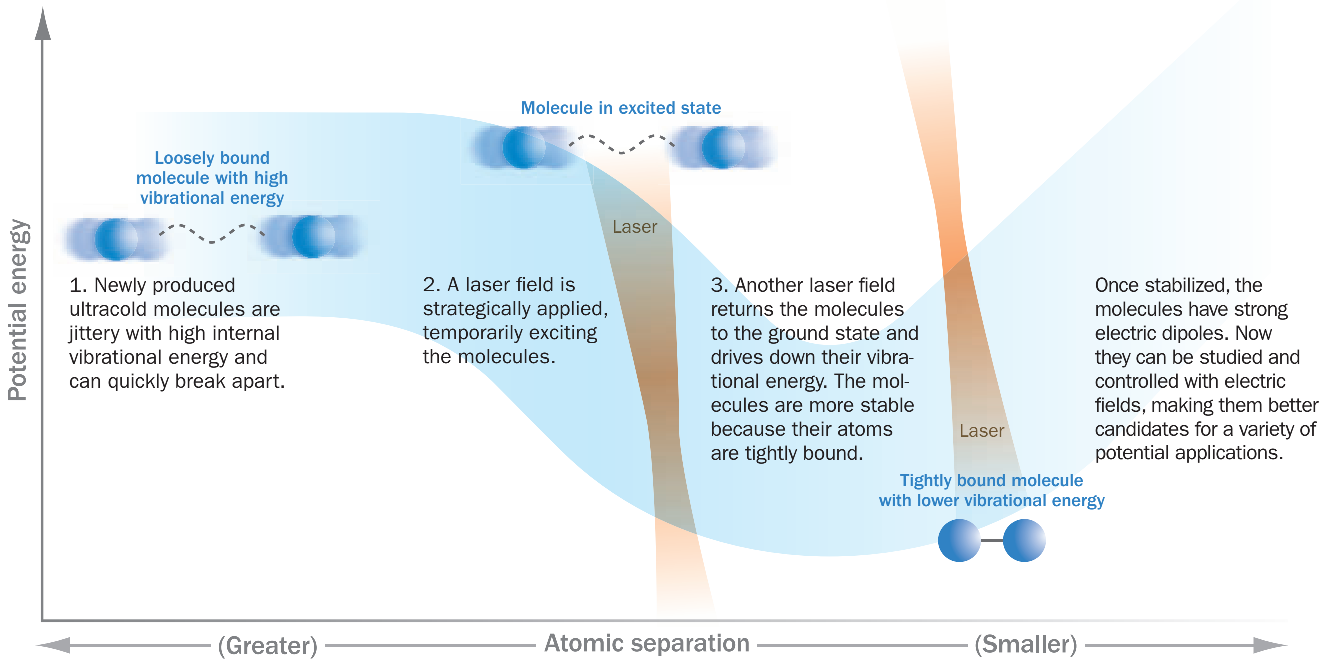
Lithium-cesium and potassium-rubidium are both polar molecules, with a positive electrical charge at one end and a negative charge at the other. These charge separations, or dipole moments, play some critical roles in the real world. For example, they are responsible for ice's ability to float atop water. Because the water molecule is positive near the hydrogen atoms and negative near the oxygen atom, at low temperatures the molecules assemble themselves into structures that are less dense than liquid water. "The fact that certain molecules have dipole moments means that they can interact with each other in interesting ways," says physicist Phillip Gould of the University of Connecticut in Storrs.

In the case of potassium-rubidium, the negative potassium atom interacts with the positive rubidium atom and forms a permanent separation of charge that gets stronger as the atoms are more tightly bound. These charges, which extend far beyond the edge of the molecule, are like little handles that researchers can grab with a magnetic field.

Using the positive and negative handles of these molecules to direct chemical reactions in ultraslow motion makes ultracold chemistry possible. Knowing every detail about these molecules' charges and energy levels will allow researchers to monitor in excruciating detail exactly how two molecules interact. What's more, because ultracold molecules can be forced to get very close to each other, the interactions between

Into the freeze

To make ultracold molecules, physicists must coax the molecules into their lowest possible energy state, the ground state, in which internal rotation and vibration are virtually eliminated. Various techniques have been developed to achieve this. One approach, shown here, has tamed ultracold molecules of potassium and rubidium.



RESEARCH: KAREN PATTERSON, ART: J. KORENBLAT

them will be different from interactions in normal chemical reactions. The subatomic nuances — the warts and hairs on the molecules that normally would be obscured by motion — will be visible. "Basically, we're learning to control atoms and molecules in very precise ways," Julienne says.

This control could lead to new technologies. Although Julienne calls it a "pie-in-the-sky" idea, ultracold molecules may bring physicists closer to building a quantum computer, which relies on the features of quantum physics to transfer and store information. Basing a quantum computer on ultracold, polar molecules may bring about faster, more secure computers (*SN: 8/16/08, p. 24*) by exploiting the long-range effects of charged molecules. "No one anticipated the speed with which these [ultracold polar] molecules would emerge. We can now seriously dream of quantum computers," Weidemüller says. "Our kids will see quantum computing."

Cold chemistry and quantum computing may not even be the strangest things on the ultracold molecule horizon. The strong dipole interactions that these polar molecules exhibit may allow physicists to create new forms of matter that don't yet exist in nature, Ye says.

Weidemüller concurs: "The predictions are that there will be new kinds of phases" that arise from this breakthrough.

New, strange phases of matter may include things like a molecular supersolid, a type of matter in which the molecules would be arranged in a solid shape but could flow inside the solid without friction. The creation of a supersolid made of helium atoms was first reported in 2004, but the finding remains controversial. Also intriguing is a particular kind of matter that might form when ultracold molecules are bound to one another by their dipole interactions, says Benjamin Lev, a physicist at the University of Illinois at Urbana-Champaign. This interconnected series of molecules could have applications for superconductivity, the frictionless flow of electrons (*SN: 12/20/08, p. 13*). Understanding how superconductivity works at very low temperatures may ultimately lead to the creation of superconductive types of matter that would work at higher temperatures, a much-anticipated feat that would "revolutionize power grids around the world," Lev says.

"The ultracold regime is completely new to the world, and it may produce new phases that no one even thought of," says Lev, whose own research is aimed at exploring exotic matter formed by dipolar atoms.

With the creation of just a handful of types of stable ultracold molecules, the field of ultracold molecules has entered its infancy. "It's one of those developments that comes along rarely but can be transformational," says Julienne. ■

Explore more

- K.-K. Ni *et al*. "A High Phase-Space-Density Gas of Polar Molecules." *Science*. Oct. 10, 2008.
- J. Deiglmayr *et al*. "Formation of Ultracold Polar Molecules in the Rovibrational Ground State." *Physical Review Letters*. Sept. 26, 2008.

Brain imaging reveals the substance of placebos. Expectation alone triggers the same neural circuits and chemicals as real drugs.

By Jeanne Erdmann **Illustration by Bryan Christie**

Imagination Medicine

Placebos are supposed to be nothing. They're sugar pills, shots of saline, fake creams; they're given to the comparison group in drug trials so doctors can see whether a new treatment is better than no treatment.

But placebos aren't nothing. Their ingredients may be bogus, but the elicited reactions are real. "The placebo effect is in some way the bane of the pharma industry's existence because people have this nasty habit of getting better even without a specific drug," says David Spiegel, a psychiatrist at Stanford University School of Medicine.

It all boils down to expectation. If you expect pain to diminish, the brain releases natural painkillers. If you expect pain to get worse, the brain shuts off the processes that provide pain relief. Somehow, anticipation trips the same neural wires as actual treatment does.

Scientists are using imaging techniques to probe brains on placebos and watch the placebo effect in real time. Such studies show, for example, that the pleasure chemical dopamine and the brain's natural painkillers, opioids, work oppositely depending on whether people expect pain to get better or worse. Other research shows that placebos can reduce anxiety.

The first brain imaging study to show what happens in the brain during the placebo effect was not necessarily aiming to do so. Its goal was to use brain scans to study what happens when people take apomorphine, which is a drug for Parkinson's disease, a condition marked by a lack of dopamine. The drug brings quick relief but is infamous for its unpleasant side effects of dizziness and nausea. Led by neurologist Raúl de la Fuente-Fernández of the University of British Columbia in Vancouver, the project used PET scans to monitor the activity of the brains of Parkinson's patients the same day patients took the drug. PET scans are tools to identify where the brain is activated and which brain chemicals are involved in a task.

But patients in the study experienced so many side effects from the drug that the researchers had to cancel the PET scans. De la Fuente-Fernández wondered whether the combination of undergoing PET scans and worry over side effects made some patients react to the drug more strongly than they should have. So he changed the protocol. On scanning days, investigators gave the drug in several injections rather than a single dose. Participants knew that one dose was placebo, but not which one.

That simple adjustment reduced side effects, kept the trial going and led to a *Science* paper in 2001 showing that placebos trigger dopamine release through the same circuitry as Parkinson's drugs. This finding was "serendipity, just serendipity," says de la Fuente-Fernández.

Seeing expectations in action can help scientists understand how the brain carries out the placebo effect. The hope is that such research can point to when, how and why the effect occurs, leading to better drugs and improved clinical care.

Believing is relieving

People receiving a placebo in a clinical trial often respond as though they are getting a real drug. At the University of Michigan in Ann Arbor, neuroscientist Jon-Kar Zubieta studies this phenomenon in the laboratory.

Earlier work by Zubieta and colleagues has shown that the anticipation of pain relief discharges opioids from pain control centers in the brain. Opioids are part of the brain's pain-relief strategy and are activated by stress. Other chemical messengers, such as dopamine, join in too. In the nucleus accumbens, dopamine is released when the brain sees a reward coming, such as food or sex. Dopamine

drives the reward response, and Zubieta wondered whether dopamine also participates in the placebo effect.

Modeling the experiments on clinical trials, Zubieta's team told participants that they would be testing a new medication that would relieve pain by activating the brain's natural pain-relief centers. Participants were told that they would receive a placebo or the drug. Finally, they were told that they wouldn't know whether the drug worked or not but that investigators would know because of the brain-scanning equipment.

The scientists then administered the "pain relief" (which did not include, in fact, any actual drugs, only placebo) and exposed participants to pain by injecting low-concentration saltwater into a large jaw muscle for 20 minutes. PET images were taken of the participants' brains during the exposure. Pain lessened for some and strengthened for others — just what happens in clinical trials, the researchers reported in the February *Archives of General Psychiatry*.

In participants whose pain symptoms improved, the nucleus accumbens released dopamine and opioids. In those who reported more pain and discomfort, the brain shut down dopamine and opioid release through the same pathways.

But even in such tightly controlled laboratory experiments, not all people respond to placebos, and not all respond the same way. In another experiment, the same volunteers played the monetary incentive delay task, a gambling game. Reward was expected, but not reward in the form of relief from pain. Using fMRI, the researchers monitored neural activity and found that indeed the nucleus accumbens was activated during anticipation of monetary reward. And in each person, that activation was proportional to the person's capacity for a placebo-generated release of dopamine during the pain experiments, the team reported in 2007 in *Neuron*.

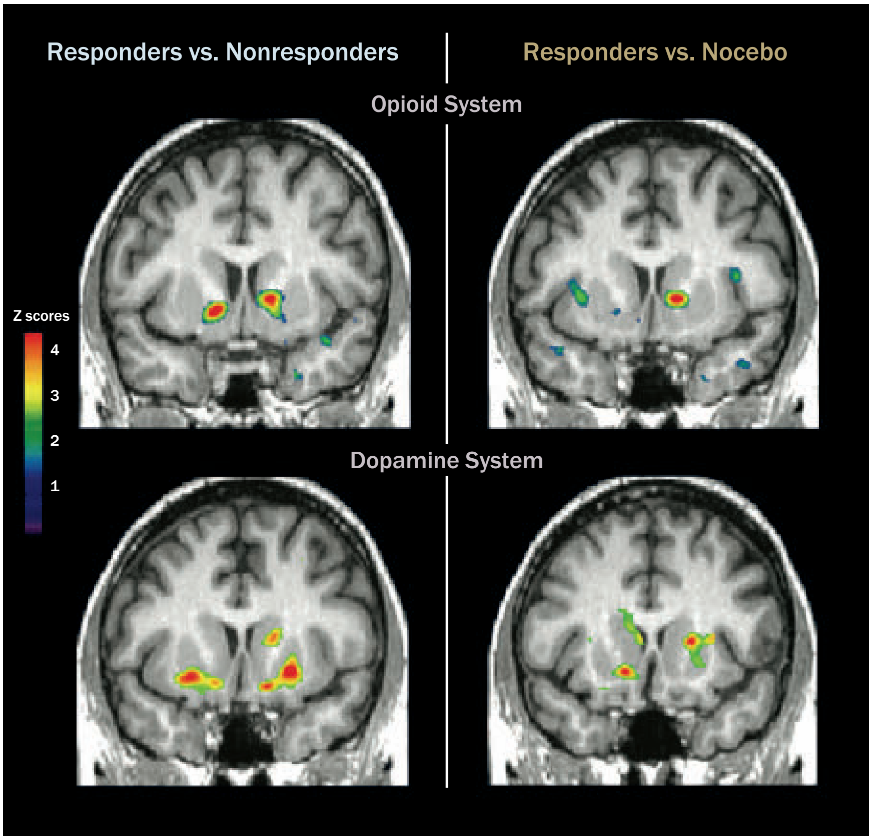
"Both dopamine release and activity during reward anticipation predicted analgesia," says Zubieta.

Pain or relief, same network

Pain, Parkinson's and even anxiety over medicine may seem unconnected, but these conditions share circuits in the cerebral cortex — the part of the brain that evaluates a situation and its consequences — and in the brain stem, a routing area for information going to and from the brain. Think of the brain as a distribution of networks. Each may have a different job but all the regions are connected.

Many brain areas overlap with those involved in pain and stress because pain and mood affect each other. Depression and movement problems are typical symptoms of Parkinson's disease, and dopamine levels are crucial to both.

Think of these brain areas as networks of reverberating circuits that size up a situation and assign an emotional value, says Tor Wager, a neuroscientist at Columbia University in New York City. "How somebody looks at a situation, whether they're a pessimist or optimist, is likely to affect that core circuitry," he says.



Relief, pain, nothing

MRI scans reveal variation in how the brain carries out different reactions to pain.

A team led by Jon-Kar Zubieta of the University of Michigan aimed to measure the impact on two chemical messenger systems in the brain — the endogenous opioid and dopamine systems — when pain was induced and a placebo "treatment" was administered at regular intervals. Volunteers continually rated the intensity of the pain.

With brain imaging, the researchers found a placebo response in regions associated with response to reward, and at a degree that matched both the level of pain relief people had anticipated and the pain relief they felt.

The colored areas in the top left MRI image indicate where opioid activity in the brains of responders — people who felt relief with placebo — was different than it was in the brains of nonresponders, people who felt no change. Similarly, the colored areas in the top right image show where opioid activity in the brains of responders was different than in the brains of nocebo feelers — those who actually reported *increased* pain and discomfort. The two lower images make the same comparison for the dopamine system.

ZUBIETA, *ARCHIVES OF GENERAL PSYCHIATRY*, 2008

Wager's research joins a trio of early studies linking placebos to these brain networks. In 2004, Wager showed that expectations alone bring the prefrontal cortex online even before participants get a painful stimulus.

Earlier, Predrag Petrovic, a psychiatrist at the Karolinska Institute in Stockholm, showed that placebo activates the same brain areas involved in pain relief. Petrovic suspects that the prefrontal cortex sends signals to the anterior cingulate cortex, or ACC, which interprets pain as a threat and activates natural painkillers through a fiber network reaching to the brain stem. "Before, people thought placebos were a passive process," says Petrovic.

Petrovic and colleagues then wondered whether the placebo response for emotional processing uses the same brain circuits as pain processing. They set up an experiment designed to manipulate anxiety. On day one, scientists gave participants an antianxiety drug and then, during a brain scan, showed photos ranging from scary to neutral. For example, one photo showed a gun pointing at the participants' faces, another a rolling pin.

The next day, the researchers told participants they would get the same drug and view the same photos. Instead, participants received placebo, and again their brains were scanned while they looked at the pictures. Comparing scans showed that the placebo and the real antianxiety drug activated the same area of the prefrontal cortex and ACC. "We know now that we're actually activating systems that can either make it better or worse for the patient just by what we tell them and how we tell them," Petrovic says.

The white, round pill

One reason the placebo response works is because people consciously or unconsciously connect environmental cues and a healing response. The color and shape of aspirin, a doctor's white coat, the dentist's chair or a stethoscope form the social context in which the placebo effect occurs.

Fabrizio Benedetti, a neurologist at the University of Turin in Italy, calls these stimuli the psychosocial context, things that "tell the patient that a therapy is being performed." Aspirin pills are white and round and contain acetylsalicylic acid. Time after time, people take aspirin and headaches disappear, so a link forms between the color and shape of aspirin pills and the effects of acetylsalicylic acid. Before long, people learn to respond to any white and round pill, even one with sugar inside, says Benedetti.

Doctors can bring the placebo effect to the clinic without lying to patients. And doctors can harness the psychosocial context to reduce the intake of dangerous painkillers. Benedetti provides an example: A doctor gives morphine on Monday, Tuesday and Wednesday. On Thursday, the doctor replaces morphine with placebo. Then the doctor repeats the cycle of three days with morphine, one day with placebo. In the long run, doctors can reduce the intake of morphine, which is exactly what Benedetti and colleagues did in a clinical experiment. "We were able to reduce the intake of buprenorphine [a morphinelike drug] by about 34 percent in postoperative pain," says Benedetti.

The biggest problem with using placebos is ethical because doctors have to convince patients they're getting a real drug. Benedetti suggests telling patients the truth by saying: " 'I'm going to perform a procedure which is known to activate endogenous analgesic substances in your brain. Thus, your pain will subside in the next few minutes.' Even though you give a placebo, I believe there is no deception in this sentence."

Placebos for better drugs

So far, imaging techniques have provided the tools to measure the emotional aspect of medical treatment. Lots of work needs to be done, though, before scientists can fully harness placebo power. Still unknown is why the placebo response sometimes lasts less than an hour and how to make responses last longer.

Almost no system in the brain or body works alone. Imaging research using the placebo effect could help scientists figure out which systems are most important in the human brain, in diseases and in behavior, says Mark Mintun, a radiologist at the Washington University School of Medicine in St. Louis. In Parkinson's, for example, imaging the effect shows how much the brain depends on the ability to fine-tune the complicated dopamine system. In people with Parkinson's, disease brings changes to mood and movement. Imaging the effect in this condition could reveal dopamine receptors that influence both reward and muscles, says Mintun.

"We don't do placebo research just so we can come up with a new therapy," Mintun says. "Sometimes we have to make sure that we understand what we're being fooled by. If you find out all you're doing is activating the placebo network every time you give somebody a drug and tell them how great they're going to feel, then clearly that drug may not be doing any good."

Even though imaging has homed in on where in the brain the placebo effect happens, still unknown are the details of what is happening in those regions. Imaging studies have located the placebo effect to areas such as the nucleus accumbens, but this area connects to a number of brain regions. Just locating an area doesn't explain the role of the connections. The brain usually has multiple ways of achieving things such as movement or pain relief. So the effect may tap into other pathways, says Mintun. Once the pathways are understood, scientists could exploit the effect to help people with conditions that are difficult to treat, such as chronic pain.

"One of the fun steps would be to understand whether the brain mechanisms involved in the placebo effect could give us new insights for how to develop treatments," Mintun says. "Clearly, if you can make somebody feel better or make them move better by marshaling a new network in their brain, then we could tap into that with drug therapy. We might be able to enhance current therapies or create a brand new therapy." ■

Explore more

■ F. Benedetti. "Mechanisms of Placebo and Placebo-Related Effects Across Diseases and Treatments." *Annual Review of Pharmacology and Toxicology.* 2008.

FEEDBACK

NASA's source

In "Cooling climate 'consensus' of 1970s never was" (*SN: 10/25/08, p. 5*), *Science News* includes a graph, attributed to NASA, that shows temperature deviations from the year 1880. The data clearly indicate a distinct warming trend throughout the period. Why is it that over the past two years I have very painstakingly researched the data from more than 200 weather stations from every continent, including more than 20 north of the Arctic Circle, and I haven't found a single one that indicates a trend that even remotely resembles that represented by the graph in your article? The difference between my primary research and the data from NASA is disconcerting.

As a high school environmental science teacher, I don't know whether to teach my students of the threat of global warming or of the terrible hoax being played by the world's scientists in whom we entrust so much. Will someone please provide the locations of specific weather stations that indicate the trend shown by the NASA graph, instead of just showing NASA's compilation of weather station data?

Edward Amatetti, Gaithersburg, Md.

The NASA graph depicts a year-by-year estimate of average global temperature, not the temperature recorded at any individual weather station. That estimate includes data gathered at more than 500 land-based weather stations, says Reto Ruedy, a mathematician and climate modeler at NASA's Goddard Institute for Space Studies in New York City. Since December 1981, sea-surface temperatures have been estimated from satellite observations; before then, such data were gathered at sea by commercial and government research vessels. —Sid Perkins

How Thākur got its name

I read with interest the article "Other side of Mercury" (*SN: 11/8/08, p. 8*). In the article Ron Cowen mentions a crater named Thākur. This is a Bengali word, and I would appreciate if you can tell me some details about how this crater came to be named.

Madan Mukhopadhyay, Bakersfield, Calif.

According to planetary scientist Sean Solomon of the Carnegie Institution for Science in Washington, D.C., the name Thākur was chosen in the 1970s after images of Mercury were taken by the Mariner 10 craft. Mark Robinson of Arizona State University in Tempe provides more details: Craters are named for deceased artists, musicians, painters and authors who have made outstanding or fundamental contributions to their fields and have been recognized as historically significant figures for more than 50 years. According to the website planetarynames.wr.usgs.gov, this crater is named for a Bengalese poet, novelist and Nobel laureate.—Ron Cowen

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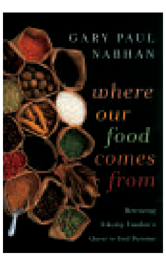
BOOKSHELF

Where Our Food Comes From: Retracing Nikolay Vavilov's Quest to End Famine

Gary Paul Nabhan

Few people give thought to where the tomato, apple or walnuts in their salad came from. Or what grains gave rise to the wheat in their bread or barley in their beer. University of Arizona ethnobotanist Nabhan was intensely curious about these questions—and about the exploits of the man he credits with first traveling the world to find the genetic birthplace of the foods we depend upon.

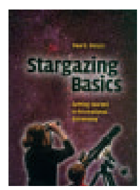


Born in 1887, Nikolay Vavilov is known for creating the world's first major seed bank. To assemble that living genetic library, which still survives in St. Petersburg, Russia, he organized 115 research expeditions through some 64 countries and collected seeds of food crops from five continents. For this book, Nabhan hiked in Vavilov's footsteps to many of the same centers of agricultural diversity.

Even up to 90 years after Vavilov's journey, many spots remain exotic and little changed. On the "roof of the world" in Tajikistan's Pamiri highlands, Nabhan saw where Vavilov acquired more than 200 seed collections, including onions, wheats, lentils and chickpeas. In Italy's Po Valley, Nabhan saw the same olives, capers, grapes and salad greens that impressed Vavilov. Trips also took Nabhan to Lebanon, Ethiopia, the American Southwest and Mexico's Sierra Madre—which Vavilov called the mother lode of food biodiversity.

Equal parts travelog, biography and botanical history, Nabhan breathes life into the exploits of Russia's botanical adventurer. —*Janet Raloff*

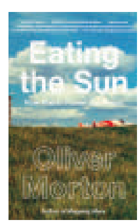
Island Press, 2009, 223 p., $24.95.



Stargazing Basics: Getting Started in Recreational Astronomy

Paul E. Kinzer

A beginner's guide to the equipment and knowledge needed to enjoy the nighttime sky. *Cambridge Univ., 2008, 147 p., $19.99.*



Eating the Sun: How Plants Power the Planet

Oliver Morton

An exploration of how photosynthesis makes life on Earth possible, with implications for climate change policy. *HarperCollins, 2008, 460 p., $28.95.*

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Edward O. Wilson

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Protect biodiversity hot spots and the rest will follow

Edward O. Wilson of Harvard University has written and lectured widely in fields ranging from sociobiology and evolutionary psychology to conservation biology. He spoke recently on "sustainability" at Baldwin-Wallace College in Berea, Ohio. Wilson believes that too much emphasis has been placed on trying to reduce energy consumption and avert climate change — what he calls the "physical environment" — and too little on preserving habitat and biodiversity, or the "living environment." For Wilson, preserving the living environment means protecting areas of the world with the most concentrated biodiversity. He also believes that poverty is a critical factor that needs to be addressed to achieve a sustainable world. Freelance science writer Diana Steele excerpted his remarks:

The tragedy unfolding in our ignorance, in our preoccupation with strictly physical environments, is that human action is destroying countless species and even ecosystems before we even know they existed. Many of them are millions of years old; all of them are exquisitely adapted to some particular part of the environment.... If you save the living environment, that's the rest of life around us, and the full diversity of it, then you will automatically save the physical environment too. But if you save only the physical environment and ignore the living environment, you will ultimately lose both....

The 21st century, I believe, is going to be noted as the century of the environment. The immediate future can be usefully conceived as a bottleneck, of still-rapid population growth and high per capita investment and consumption. Science and technology, combined with a lack of self-understanding and the Paleolithic obstinacy that led to our ruinous environmental practices, have brought us to where we are today....

You can remember it best by thinking of us as being a Star Wars civilization: We have Stone Age emotions, medieval institutions and God-like technology. That's the source of all of our problems.

Now, science and technology — combined with foresight and moral courage, both based from a more enlightened ethic, an educated one — has to see us through this bottleneck.... [We need to] identify the hot spots: Those are the areas that have the largest number of endangered species. The habitats in them are mostly endangered and have the largest number of endangered species that will go extinct if the habitat is allowed to be destroyed....

JUSTIN IDE/HARVARD NEWS OFFICE

If you save only the physical environment and ignore the living environment, you will ultimately lose both.

Fifty percent of all the known species of vascular plants, and 42 percent of all the mammals, birds, reptiles and amphibians, are in those hot spots, which occupy about 4 percent of the land's surface....

It's been estimated that that 4 percent or so can be preserved, taking care of the people who live in and around it, economically, [for one payment of] about 50 billion euros.... That is one part in 1,000 of the annual combined gross domestic products of the world's countries. Could we come up with one part in 1,000, to save upwards of half a percent of the endangered species living on the Earth's surface? That's the kind of political solution and economic solution which would be impressive....

The central problem of the new century ... and the one that's going to count big time, long-term, is how to raise the poor to a global quality of life while preserving as much of the natural world as possible. Both the poor and biological diversity are concentrated together in the developing countries. The solution to this problem has to flow from the recognition that both depend on the other. The poor ... have little chance to improve their lives in a devastated environment. Conversely, the natural environment where most of the biodiversity hangs on cannot survive the press of land-hungry people who have nowhere else to go....

This is a problem that can be solved; the resources to solve it exist. Those who control them have many reasons to achieve that goal (not least their own security): The payout in science products, benefits, would be enormous compared to the relatively small costs globally that are required. The technology to do this exists, the cost really isn't very high and the benefits are beyond calculation....

[The Encyclopedia of Life (*SN: 3/8/08, p. 158*)] is nothing less than using the best computer technology to record everything known about every known species.... Our aim is to have everything known about every one of the known species in 10 years, and then to start ... rapid adding of new species until we reach the top, or come close to the end, which could be 10 million species. It could be a hundred billion species....

[All of the information in the Encyclopedia of Life] will be available to anyone, free, anytime, anywhere. This will open research everywhere in the world, even in developing countries and so on, by giving access to what otherwise you would not have been able to get without visiting the museums, without getting the specimens, without going through the libraries, and working laboriously alone. ■

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