Flower Power | Hot Town, Warm in the City | Oxygen's Early Debut

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ APRIL 11, 2009

Planck

Mapping the first moments of the universe

$3.95 U.S. | www.sciencenews.org

Solidifying Superfluids

Peanuts for Peanut Allergy

Down with Prokaryotes

Vote in the Greatest Election That Never Was: Washington vs. Jefferson

Celebrate America's greatest Founding Fathers with Stauer's historic Presidential Dollar Timepieces.

Think our country's last Presidential election made history? Wait until you see who we have going head-to-head in the **Greatest Election That Never Was**! It's Washington vs. Jefferson, *the Father of our country vs. the Sage of Monticello*. We've taken the Washington and Jefferson Presidential Dollars issued by the U.S. Mint and created the limited edition historic presidential timepieces. Finally, you get the opportunity to rewrite history by casting a vote for your favorite Founding Father. And since we give you a $100 gift certificate with every $95 watch, we are literally trying to buy your vote.

In this corner: the Man from Mount Vernon. Does George "I Cannot Tell a Lie" Washington really need an introduction? After all, it was the courageous General Washington who led the Continental Army in their defeat of the British in 1783. For a victory lap, he served two terms as our nation's first President. He was hailed as the "Father of His Country" before he even took office. And Congressman Henry Lee declared Washington, "First in war, first in peace, and first in the hearts of his countrymen."

His challenger: the Sage of Monticello. Quite simply, Thomas Jefferson was a genius. The brilliant author of the Declaration of Independence originated the phrase, "Life, Liberty and the Pursuit of Happiness" and he was the third President of the United States. But he was also a man of many talents. Besides a born leader and statesman, Jefferson was an inventor, architect and philosopher.

The crystal-protected case back features the reverse of the coin, with a majestic depiction of the Statue of Liberty.

A limited-edition celebration of American history. Each ***Founding Fathers Watch*** features a Brilliant Uncirculated U.S. legal tender Presidential Dollar set inside a handsome, gold-layered case. Detailed portraits of Washington and Jefferson serve as the faces of the watch. An elegant sapphire caps the crown. The watch is water-resistant to 3 ATMs and fastens with a genuine crocodile-embossed leather band.

Cast your vote in the "election" by ordering the watch of your choice for only $95. **As an added bonus**, each watch will arrive with its own Presidential Stimulus Package: a **$100 Stauer Gift Certificate**. We are so sure that you will be thrilled by the quality and history of the Stauer ***Founding Fathers Watch*** that we offer a 30-day money back guarantee. If you are not truly impressed by the precision, history and design, just return it for a full refund of the purchase price. This is a limited edition, so place your vote today.

WATCH SPECS:
- Brilliant Uncirculated Presidential Dollar; face and back
- Gold-fused case - Croc-embossed leather strap
- Fits a 6 ¾"–8 ¾" wrist - Water resistant to 3 ATM

Stauer *Founding Fathers Watch*
Vote for George Washington ~~$195~~
Now **$95**
Vote for Thomas Jefferson ~~$195~~
Now **$95**

***Special Offer*—Receive a $100 Stauer Gift Certificate with the purchase of each *Founding Fathers Watch*.**
Call now to take advantage of this limited offer.

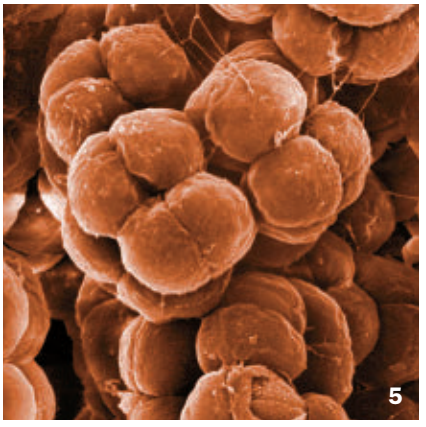
1-888-277-8381

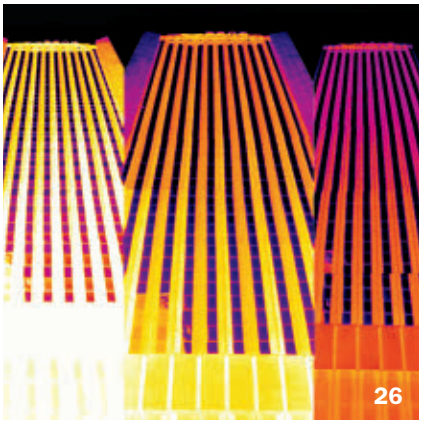
Promotional Code APW133-01
Please mention this code when you call.

Stauer
14101 Southcross Drive W.,
Dept. APW133-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

APRIL 11, 2009 • VOL. 175 • NO. 8





ScienceNews

In The News

5 STORY ONE

- Debating *prokaryote* as a pejorative

8 LIFE

- Baby monkeys whine and win
- Eel larvae float with goo

9 EARTH

- An earlier breath of fresh, oxygenated air for planet
- Looking to the dirt to better forecast hot spells

10 MOLECULES

- Flower woos pollen with proteins
- Right light makes for a quick molecular fix

11 BODY & BRAIN

- A gradual approach to combating peanut allergy

12 ATOM & COSMOS

- Salty subsurface pools may lace Red Planet
- Magnetic waves give the sun's corona extra heat

13 PHYSICS: SPECIAL MEETING REPORT

- Spotting a supersolid in an ultracold gas

14 HUMANS

- Music moves everyone in the same emotional key
- New, older age for famous Peking Man fossils

Features

16 PLANCK BY PLANCK

COVER STORY: A mission set to launch this spring will map the cosmic microwave background radiation at the highest resolution yet and reveal new details of the universe's beginnings.
By Ron Cowen

22 BUILDING BEAUTY

Scientists seek to understand flowers' structures, scents and colors from the genes up.
By Rachel Ehrenberg

26 URBAN HEAT

Cities are already the hottest places to be. Add a growing population to global warming, and urban heat islands could become real cookers.
By Sid Perkins

Departments

2 FROM THE EDITOR

4 NOTEBOOK

30 BOOKSHELF

32 COMMENT

Climate change may be global but preparing for its effects should be local, says Michel Jarraud of the U.N. World Meteorological Organization.

COVER Artist's impression of the Planck satellite in space
ESA (Image by AOES Medialab)

ScienceNews MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

publisher Elizabeth Marincola *editor in chief* Tom Siegfried

EDITORIAL STAFF *managing editor* Eva Emerson
senior editor/policy Janet Raloff
assistant managing editor Kristina Bartlett Brody
news editor Elizabeth Quill *associate editor* Emily Krieger

astronomy Ron Cowen
behavioral sciences Bruce Bower
biomedicine Nathan Seppa
earth sciences Sid Perkins
environment/chemistry Rachel Ehrenberg
life sciences Susan Milius
molecular biology Tina Hesman Saey
staff writer Laura Sanders
editorial assistant Rachel Zelkowitz
web specialist/editorial secretary Gwendolyn K. Gillespie
science writer intern Solmaz Barazesh

DESIGN *design director* Bob Gray
assistant art directors Joshua Korenblat, Avik Nandy

ADVERTISING | CIRCULATION
advertising manager Judy Lewis *West & Mid-Atlantic*
circulation manager Tosh Arimura
account executives Regan Pickett *Midwest & South*
Gregg Oehler, Rich Cordero *Oehler Media, Northeast*
advertising/circulation assistant Kerwin Wilson *permissions* Evora Swoopes

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
1719 N Street NW, Washington, DC 20036 · Phone (202) 785-2255
Audit Bureau of Circulations
Subscriptions subs@sciencenews.org · ***Editorial/Letters*** editors@sciencenews.org
Advertising/Business snsales@sciencenews.org
Texterity Digital edition provided by Texterity, www.texterity.com
Science News (ISSN 0036-8423) is published biweekly, for $54.50 for 1 year or $98 for 2 years (international rate $80.50 for 1 year or $161 for 2 years) by Society for Science & the Public, 1719 N Street NW Washington, DC 20036. Preferred periodicals postage paid at Washington, DC, and an additional mailing office.
Subscription Department: PO Box 1205, Williamsport, PA 17703-1205.
For new subscriptions and customer service, call 1-800-552-4412.
Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

FROM THE EDITOR

Planck mission will help achieve Planck's mission

When Max Planck enrolled at the University of Munich in 1874, he planned to study mathematics. But then physics caught his attention and he changed his major, despite a professor's warning that everything worth knowing about physics had already been discovered.

But Planck persevered with physics. He wanted to understand the nature of the universe more deeply. And that is precisely the goal of the spacecraft soon to be launched bearing Planck's name.

Planck (the man) became an authority on thermodynamics. In 1900, while pondering disparities between theories of how hot bodies should glow and actual experiments, he arrived at a formula that revolutionized science, relating radiation's frequency to its energy by a mathematical constant that, like the new spacecraft, bears Planck's name.

Planck (the man, not the constant) quickly realized that his formula muddled the view of radiation (light and all its electromagnetic relatives) as smooth and continuously divisible. Instead, it was absorbed and emitted in chunks called quanta. Planck resisted the implication that light also traveled through space as quanta, but Einstein forced the world to accept the whole meaning of what Planck had perceived.

Back then, a century ago, nobody realized that Planck's quanta were the key to understanding the universe itself. But now cosmologists "know" (physics jargon for "strongly suspect") that quanta from the beginning of time generated seeds of matter that grew into the galaxies that populate the cosmos today. Explaining the origin of the galaxies, the stars, star products (such as people) and even, perhaps, the universe all depends on mapping the quantum signatures written in the radiation that the Planck spacecraft will scrutinize.

Ron Cowen's description of the Planck mission (Page 16) provides details of the science — the efforts to detect polarized radiation and infer the activity of gravitational waves, attempts to understand the immediate aftermath of the Big Bang and theories explaining it, the quest to identify the strange repulsive energy that accelerates the universe's expansion. These endeavors represent the pinnacle of human pursuit of answers to the deepest questions about existence, the sorts of things that drew Planck to physics. It was to the world's benefit that he didn't listen to the guy who said all the physics questions had been answered.

—Tom Siegfried, Editor in Chief

One day, his son would speak to the world.

He wanted them to understand.

Rosetta Stone. The fastest and easiest way to learn CHINESE.

Arabic • Chinese (Mandarin) **• Danish • Dutch • English** (American) **• English** (British) **• French • German • Greek • Hebrew • Hindi**
Indonesian • Italian • Irish • Japanese • Korean • Latin • Pashto • Persian (Farsi) **• Polish • Portuguese** (Brazil) **• Russian**
Spanish (Latin America) **• Spanish** (Spain) **• Swahili • Swedish • Tagalog** (Filipino) **• Thai • Turkish • Vietnamese • Welsh**

Rosetta Stone® brings you a complete language-learning solution, wherever you are: at home, in-the-car or on-the-go. You'll learn quickly and effectively, without translation or memorization. You'll discover our method, which keeps you excited to learn more and more.

- You'll experience **Dynamic Immersion**® as you match real-world images to words spoken by native speakers so you'll find yourself engaged and learn your second language like you learned your first.
- Our proprietary Speech Recognition Technology evaluates your speech and coaches you on more accurate pronunciation. You'll speak naturally.
- Only Rosetta Stone has **Adaptive Recall,**™ that brings back material to help you where you need it most, for more effective progress.
- And Rosetta Stone includes **Audio Companion**™ so that you can take the Rosetta Stone experience anywhere you use a CD or MP3 player.

Innovative software. Immersive method. Complete mobility. It's the total solution. Get Rosetta Stone—**The Fastest Way to Learn a Language. Guaranteed.**®

SAVE 10%!

100% GUARANTEED
SIX-MONTH MONEY-BACK

Level 1	~~Reg. $259~~	**NOW $233**
Level 1&2	~~Reg. $419~~	**NOW $377**
Level 1,2&3	~~Reg. $549~~	**NOW $494**

Call
(877) 298-4149

Online
RosettaStone.com/qvs049

Use promotional code qvs049 when ordering.
Offer expires July 31, 2009.

RosettaStone®

Scientific Observations

"I am hopeful that the stimulus money allocated to scientific research will provide considerably greater funding and career opportunities for young scientists. This is essential to motivate more of us to commit our lives to science, to boldly address and, with luck and persistence, solve some of our world's most daunting problems, while furthering our understanding of nature and even discovering new scientific paradigms along the way."

INTEL SCIENCE TALENT SEARCH 2009 THIRD-PLACE WINNER PHILIP STREICH, 18, OF PLATTEVILLE, WIS., AT A GALA HELD ON MARCH 10 IN WASHINGTON, D.C. STREICH WON A $50,000 SCHOLARSHIP FOR DEMONSTRATING THE SOLUBILITY OF CARBON NANOTUBES, GRAPHENE AND CELLULOSE NANOCRYSTALS.

Science Past | FROM THE ISSUE OF APRIL 11, 1959

SCIENTISTS URGED TO DIG FOR SPECIMENS OF PEKING MAN — Give up the loss of the bones of ancient Peking Man, one of man's earliest ancestors, as a "perfect crime," and start digging for new specimens of this Pleistocene forebear. This is the advice to anthropologists contained in *Science* (March 27). The famous bones were lost to science during the confusion of World War II. Negotiations had been completed to ship the precious specimens to the United States ... and the bones in three cases were given to U.S. Marines who were being evacuated from Chinwangtao. But the ship ran aground in the Yangtze Kiang River, the Marines were captured, and no one knows what happened to Peking Man.... Excellent casts of the bones are available in various parts of the world which can be used for study.

Science Future

April 22–26
Annual meeting of the Society for American Archaeology to be held in Atlanta. See www.saa.org

April 29
Psychologist Daniel Levitin and Grammy Award–winner Rosanne Cash speak at *What Is Music to Your Ears? The Science of Hearing* in New York City. See www.nyas.org

June 1–3
The e-Biosphere 09 International Conference on Biodiversity Informatics will be held in London. See www.e-biosphere09.org

SN Online

www.sciencenews.org

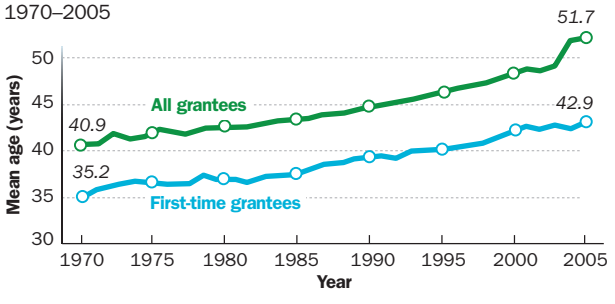
SCIENCE & THE PUBLIC
March 24 marked the 20th anniversary of the *Exxon Valdez* oil spill. A series of blogs from senior editor Janet Raloff recounts the disaster's continuing aftermath (photo below) at www.sciencenews.org/ExxonValdez20Years.

MOLECULES
Organic chemists have gained unprecedented control over making molecules based on the versatile aromatic ring structures. See "Helping molecules reach meta."

LIFE
The U.S. secretary of the interior announced that nearly a third of the country's 800 bird species are endangered, threatened or in significant decline. Read "U.S. bird populations in decline, report says."

Science Stats | GRANTEES GET OLDER

Mean age of all principal investigators receiving a major NIH research grant and mean age of first-time recipients, 1970–2005



SOURCE: CODY P. COYNE AND JOAN M. CADILLAC/*AMERICAN JOURNAL OF VETERINARY RESEARCH* 2008

Firsts

Pea aphids have carried the buddy system to the extreme. To give a symbiotic bacterium living inside them a helping hand, the insects have borrowed two genes from former bacterial residents, a team reports online March 10 in *BMC Biology*. The discovery marks the first evidence of the transfer of functional genes from symbiotic bacteria to a host animal. The two genes are active in specialized cells called bacteriomes where the current symbiont bacterium, *Buchnera aphidicola*, lives.

CLOCKWISE FROM TOP LEFT: INTEL CORPORATION; EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL; MARLIN E. RICE

“I was quite amazed that the Mafa accurately categorized basic emotions in pieces of Western music on the first listen.”
— THOMAS FRITZ, PAGE 14

Life Onlookers make monkey moms give in
Earth Predicting hot spells on the horizon
Molecules LUREs summon pollen
Body & Brain One peanut bit at a time
Atom & Cosmos Salty underground pools
Physics Special meeting report
Humans Feelings, music's universal feelings

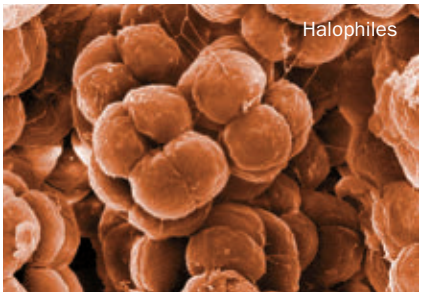
In the News

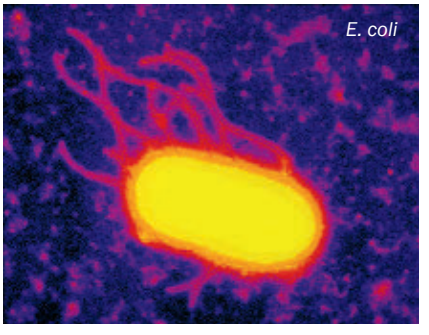
STORY ONE

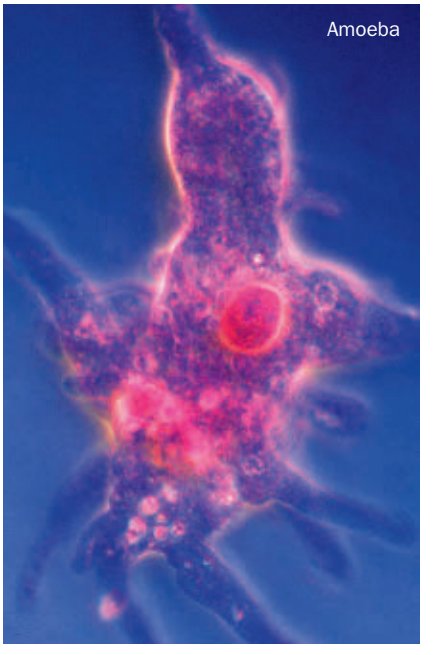
Dissing a loaded label for some unicellular life

Prominent biologist calls 'prokaryote' outdated term

By Tina Hesman Saey







Members of the three domains of life are pictured. Archaea (represented by halophiles) and bacteria (represented by *E. coli*) are often clumped together under the term *prokaryote*. Eukaryotes (represented by a single-celled amoeba) are bigger, encase DNA in a membrane and contain organelles that arose from bacteria.

Norman Pace has a problem with prokaryotes.

It's not that Pace has anything against the organisms themselves. The microbiologist and RNA scientist from the University of Colorado at Boulder has made a career of studying microorganisms. It's the term *prokaryote* that he doesn't like. At the American Association for the Advancement of Science meeting in February, he said he wants to see the word abolished.

Prokaryotes are unicellular organisms, including bacteria and archaea, that don't encase their DNA in a nucleus and do not contain membrane-bound organelles. The very name *prokaryote* implies that the microbes are precursors to eukaryotes — organisms that *do* wrap their genetic material in a nucleus and *do* have the organelles.

But not being something or not having certain features is not a scientific definition for what an organism is, Pace says. And the part about prokaryotes giving rise to eukaryotes? It's wrong, he says.

"When you read in your textbooks that eukaryotes came to be 2.7 billion years ago, it is bogus," he said at the meeting. "The eukaryote is as old as life."

Pace's contentious assertions are based on a tree of life compiled from comparisons of ribosomal RNA, one component of the protein-building machinery in cells. In 1977, Carl Woese of the University of Illinois at Urbana-Champaign first described three domains of life — eukaryotes, bacteria and archaea — using differences in the rRNA to determine relationships between the organisms. Woese's genetic reclassification of life suggested not only that bacteria and archaea are distinct groups, but also that eukaryotes and archaea are more closely related than bacteria and archaea. That view is now widely accepted.

For Pace, it's not just semantics. He says it is time to put aside the outdated concept of prokaryote and use the terms that reflect the branches of the three-domain tree. "Continued use of the term *prokaryote* perpetuates incorrect concepts about phylogenetic organization and evolution, the very foundations of biological thought," Pace wrote in January 2008 in *Microbe* magazine.

But other biologists say Pace is in the minority and is himself working with old assumptions. Newer ways of comparing DNA, they say, show different relationships among the three domains, some of which support the idea that prokaryotes did give rise to eukaryotes.

For practical purposes *prokaryote* is still useful, says William "Barny" Whitman, a microbiologist at the University of Georgia in Athens. He and Pace

CLOCKWISE FROM TOP LEFT: EYE OF SCIENCE/PHOTO RESEARCHERS; KENT WOOD/PHOTO RESEARCHERS; SCOTT CAMAZINE/PHOTO RESEARCHERS

For today's top stories, visit
SN Today at **www.sciencenews.org**

debate the usefulness of the term in a dialog published in the April *Journal of Bacteriology*.

"A lot of times experimentally you can't distinguish the archaea from bacteria," Whitman says. "So operationally, it would be cumbersome not to have a term like *prokaryote*."

He is not the only *prokaryote* fan.

"The 'pro' part of it is correct," says Michael Dolan of the University of Massachusetts Amherst. Fossil evidence points to prokaryotes preceding eukaryotes in time, he says.

Whitman agrees. "There is no evidence that the eukaryotes are primordial," he says. "Most of our evidence suggests that eukaryotes are fairly modern organisms and were preceded by prokaryotes."

But Pace says fossil evidence of nuclear membranes is irrelevant in light of the genetic data. The genetic signature of eukaryotes could have existed long before the morphological trait of having a membrane around DNA, he says.

"Biology bit into a bad apple," Pace says. "The whole issue of prokaryote-eukaryote was taken as a truth when it was still just conjecture. Prokaryote was a figment of imagination that got canonized in the institution of biology rather than the question remaining open — what are those little things? That's an interesting question. You don't just blow it off as prokaryote."

Lumping bacteria and archaea into one group gives both short shrift and denies genetic and other fundamental differences between them, Pace says. For instance, archaea have a unique membrane chemistry and their cell walls are made from materials different from what either bacteria or plants use. And archaea use proteins similar to those found in eukaryotes to package their DNA, copy instructions from DNA into RNA and build proteins.

But *prokaryote* supporters say Pace is doing a disservice to eukaryotes.

"I think professor Pace just ignores the whole issue of the fusion of genomes that is at the heart of the evolution of eukaryotes," Dolan says.

Genomic analyses show that eukaryotes carry structural genes — needed for building a cell and its components — from bacteria, while genes involved in informational processes, such as DNA synthesis, transcription and translation, are shared with archaea, says James Lake, an evolutionary phylogenomicist at the University of California, Los Angeles. His analysis suggests that eukaryotes are the product of a fusion of a bacterium and an archaeon.

"The basis for making a change to remove *prokaryote* from our vocabulary should be based on new information and analysis," Lake says.

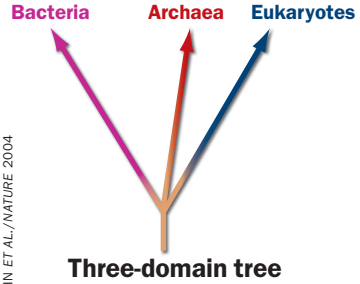
And newer studies that compare sets of genes other than rRNA suggest different arrangements for the tree of life. In a study in the Dec. 23 *Proceedings of the National Academy of Sciences*, researchers in England built many different trees of life using several statistical methods. Most of the trees don't look like the three-domain tree Pace favors. Instead, more trees suggest that eukaryotes arose from a branch of the archaea, called the eocytes or Crenarchaeota. Bacteria occupy their own branch.

"Any discussion of the tabling of *prokaryotes* should be scrapped until" the origin of eukaryotes is better understood, Dolan says.

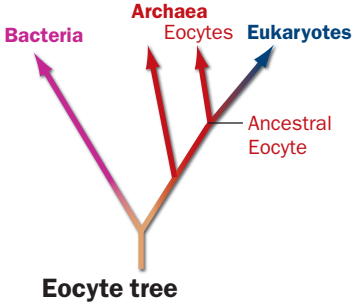
But Pace says he has enough information to justify relegating *prokaryote* to the history books. "It's got to go!" he says. "It's intellectually no longer tenable." ■

Back Story | WHAT'S IN A TREE?

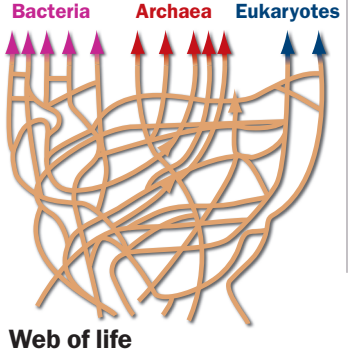
The evolutionary history of life is at the heart of the debate over whether to continue using the term *prokaryote* (an umbrella term for the bacteria and archaea domains) or to shelve it. Different views of the origin of eukaryotes might influence the debate.



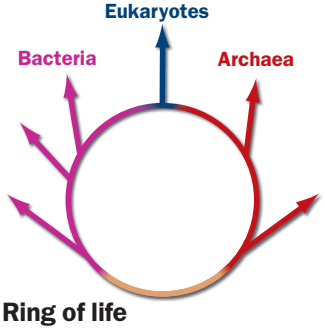
Three-domain tree
This tree is built on differences in rRNA genes and establishes bacteria, archaea and eukaryotes as separate domains of life with a common root. Norman Pace favors this tree, arguing against *prokaryote* because eukaryotes, bacteria and archaea originated at the same time, he contends.



Eocyte tree
Comparisons of many different genes give a different picture of the origin of eukaryotes. This tree shows eukaryotes branching off from a group of archaea known as eocytes. This arrangement might favor the use of *prokaryote*, since archaea preceded eukaryotes.



Web of life
Copious amounts of DNA transfer among organisms in all the domains has led to the idea that life is a web rather than a tree. In this scenario, there is no single common root.



Ring of life
UCLA's James Lake found that eukaryotes have two types of genes — one set shared with archaea and another with bacteria. His "tree" organizes life like a ring, with the fusion of bacteria and archaea producing the eukaryotes.

GRAPHICS ADAPTED FROM MARTIN *ET AL./NATURE* 2004

firstSTREET for Boomers and Beyond®

HOME LIGHTING Breakthrough

A floor lamp that spreads sunshine all over a room.

The Balanced Spectrum® floor lamp brings many of the benefits of natural daylight indoors for glare-free lighting that's perfect for a variety of indoor activities.

Ever since the first humans built a fire in their dark cave, people have realized the importance of proper indoor lighting. But ever since Edison invented the light bulb, lighting technology has, unfortunately, remained relatively prehistoric.

Modern light fixtures do little to overcome problems associated with improper lighting, such as eyestrain, dryness, and burning. As more and more of us spend longer and longer hours in front of our computer monitor, these problems are compounded. And the effects of improper indoor lighting are not necessarily limited to a physical problem: the quantity and quality of light can also play a part in both our mood and work performance.

Studies show that sunshine can both lift your mood and enhance your energy levels. But as we all know, the sun does not always shine. Now, however, there's a solution to the problem– The **Balanced Spectrum® floor lamp** will change not only the way you see, but also the way you feel about your living and work spaces. It brings the benefits of natural daylight indoors, simulating the full spectrum of daylight.

The **Balanced Spectrum's** 27-watt compact bulb is the equivalent of a 100-watt ordinary light bulb. With the lamp's sharp visibility, you will see with more clarity and enjoyment in close tasks such as reading, writing, sewing, and needlepoint. It is especially helpful for aging eyes.

Experience sunshine indoors at the touch of a switch. This amazing lamp is not only easy on the eyes, it is easy on the hands as well, featuring a special "soft-touch, flicker-free" rocker switch that is easier to use than traditional toggle or twist switches. And its flexible gooseneck design enables you to get light exactly where you need it. The high-tech electronics, the user-friendly design, and a bulb that lasts 10 times longer than an ordinary bulb–all these features make the **Balanced Spectrum® floor lamp** a must-have.

Try the Balanced Spectrum® floor lamp for the best value ever! Now more than ever is the time to add sunshine to every room in your home at this fantastic low price! The Balanced Spectrum® floor lamp comes with *first*STREET's exclusive guarantee. Try this lamp for 90 days and return it for the product purchase price if not completely satisfied.

This light can change the way you live and work

"It provides excellent lighting which is very close to true daylight. The lamp itself is light enough to be moved easily around a room and an office. The glare-free characteristics provide a very non-stressful illumination for prolonged reading."
–Stanley G., M.D.

"As soon as I turned on the lamp and began to read the newspaper I could see the wonderful difference. This lamp is just what I needed. Thank you so much."
–Donna E.

Dozens of testimonials on file.
Results not typical.

Technology revolutionizes the light bulb
- *Save almost $61 over the life of the bulb*
- *8,000 hours bulb life*
- *Energy efficient*
- *Shows true colors*

Balanced Spectrum® floor lamp

Item# BB-3589 . . . . . was ~~$59.95~~

Call now for $10 instant savings!

Only $49.95 each + S&H

*Order two Balanced Spectrum® floor lamps and get **FREE shipping** on both lamps.

*Free shipping within the contiguous 48 states only.

Please mention promotional code 37992.

For fastest service, call toll-free 24 hours a day.

1-888-651-1878

We accept all major credit cards, or if you choose, you can pay by check over the phone. To order by mail, please call for details.

www.balancedspectrum.com

firstSTREET for Boomers and Beyond®

1998 Ruffin Mill Road
Colonial Heights, VA 23834

41472

ADVERTISEMENT

Life

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

Public tantrums defeat monkey mothers, too

Bystanders make macaques more likely to give in to baby

By Susan Milius

Baby screams. Onlookers glower. Mom gives in — even when she's a monkey.

Rhesus macaque mothers are about twice as likely to let a howling infant have its way during very public tantrums than during more private moments, says Stuart Semple of Roehampton University in London.

Not a bad decision on mom's part. A baby macaque lets out a high-pitched shriek that makes onlooking monkeys restless. Mom and the unhappy baby become at least 30 times more likely to suffer aggression from a bystander during a crying bout than in quiet times, Semple and colleagues report online March 10 in *Proceedings of the Royal Society B*.

Studies of communication often focus on just two parties, the one sending the message and the intended receiver,

If a mother rhesus macaque stops a nursing session before her baby is ready, the youngster will likely throw a fit.

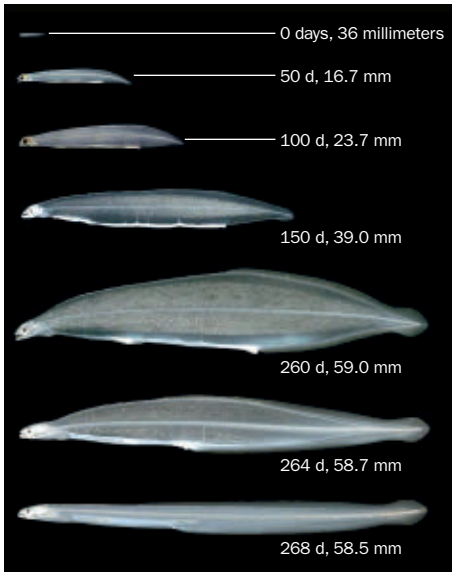
Semple says. But the real world is full of other eyes and ears. "We need to start thinking about communication in more realistic terms," he says.

This tantrum study "adds a new dimension of complexity to our understanding of mother-infant communication and mother-infant conflict in primates," says Dario Maestripieri of the University of Chicago. Research has found that non-human primates pay attention to eavesdropping bystanders, "but this is the first demonstration that communication between mother and infant is affected by an audience," Maestripieri says.

Semple and his colleagues studied rhesus macaque tantrums by watching monkeys on the island of Cayo Santiago, Puerto Rico. Infants wanting to be nursed when mom wasn't willing often started shrieking. For more than 300 outbursts of baby crying, observers noted which other monkeys, if any, were within two meters. The team also noted how mom, baby and the bystanders interacted.

Semple and the researchers picked two meters because both male and female bystanders within that range routinely reacted visibly to bawling babies. The onlookers occasionally made threatening gestures, or even chased, grabbed or bit the mother or the infant.

When moms and babies weren't close to other monkeys, rebuffed babies that started shrieking were allowed to nurse 39 percent of the time, the researchers found. With just relatives nearby, the babies' luck rose to 54 percent. But with unrelated onlookers that outranked mom in the dominance hierarchy, babies won the tantrum 82 percent of the time.



Goo gives eels the right buoyancy

Getting stats on elusive glass eels (left) has always been a slippery task. These eel larvae consist mostly of a jellylike matrix covered by a thin sheath of muscle, making them transparent. In fact, for centuries scientists thought that the young eels were their own species, separate from the more solid-bodied pigmented adults. Now scientists report the specifics of how this gelatinous goo of the larval eels keeps them afloat. A team led by Katsumi Tsukamoto and Michael Miller of the University of Tokyo surveyed the specific gravity of 25 marine critters that typically dwell in the upper layer of the oceans. Japanese eel larvae had one of the lowest specific gravities (the ratio of a material's density, in this case the critter's body, to the density of water). The young eels' specific gravities ranged from 1.019 to 1.043, lower than seawater's (1.024) in some cases. The eels probably maintain their superb buoyancy through the cells that cover their young bodies and allow them to control the flow of ions, the researchers report in the April *Marine Biology*. Specific gravity increased in the older larvae, which were beginning to grow the muscle and bone that will weigh the eels down as they grow up. — *Rachel Ehrenberg*

FROM TOP: S. SEMPLE; TSUKAMOTO *ET AL./MARINE BIOLOGY*

Earth

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

Tiny crystals in Australian rocks suggest earlier debut for oxygen

Hematite hints photosynthesis began by 3.46 billion years ago

By Sid Perkins

Tiny crystals of iron oxide in ancient Australian rocks offer evidence that the Earth's atmosphere held significant amounts of oxygen far earlier than previously thought, a new study suggests.

Large quantities of oxide minerals in rocks worldwide indicate that the atmosphere had at least small amounts of oxygen by 2.2 billion years ago (*SN: 1/24/04, p. 61*). And other, more contentious, finds suggest that oxygen-making organisms had evolved by 2.7 billion years ago (*SN: 11/22/08, p. 5*).

Now, analyses of rocks laid down 3.46 billion years ago push back the oxygen era even further, Hiroshi Ohmoto of Pennsylvania State University in University Park and colleagues contend online March 15 in *Nature Geoscience*.

Hematite, one type of iron oxide, can form in a variety of ways. If ultraviolet light strikes iron hydroxide minerals, it triggers a reaction that drives away water and leaves hematite behind. In an environment that lacks UV light, however, hematite forms only via a reaction between iron and oxygen.

Analyses of samples from Australia's Marble Bar Chert — a rock formation in the northwestern part of the country — suggest the hematite there formed underwater, in the absence of UV light.

H. OHMOTO ET AL./NATURE

Hematite in Australia's Marble Bar Chert (shown) suggests oxygen showed up in the atmosphere earlier than thought.

The chert formation lies between two thick layers of volcanic rock. The cooled lavas in those formations aren't frothy with bubbles, suggesting the strata formed under high pressure — probably on a seafloor at least 200 meters deep, Ohmoto says. The hematite in the chert's uppermost layers — those laid down as sediments around 3.46 billion years ago — is the key evidence for plentiful oxygen, Ohmoto says. Those particles are single crystals, indicating that they weren't produced by UV-driven degradation. Geochemical analyses also suggest that the crystals formed as hot, iron-rich hydrothermal fluids spewed from an ocean floor into cool, oxygenated waters.

"I'm convinced the environment there was oxygenated," says Paul Knauth of Arizona State University in Tempe.

The implications are profound: If oxygen existed at near-modern levels in such a broad, deep body of water, the atmosphere must have been oxygenated also. Presumably that oxygen was produced by organisms capable of photosynthesis, also pushing back their appearance.

Clues in soil may warn of hot spells

Satellite data could improve forecasts of regional effects

By Sid Perkins

Satellite observations of soil moisture, combined with regional climate models, could help scientists better predict the size and scope of future heat waves.

One of the most devastating heat waves in recent years struck Europe in 2003 (*SN: 7/3/04, p. 10*). Along with an estimated 70,000 heat-related deaths across the continent — many of them in France, the epicenter of the heat wave — droughts before and during the hot spell helped trigger forest fires and crop losses, Richard de Jeu, an environmental scientist at VU University Amsterdam and colleagues report online March 4 in the *Journal of Geophysical Research–Atmospheres*. The combination of high temperature and drought trimmed the continent's foliage growth, on average, by about 30 percent that year (*SN: 10/15/05, p. 254*).

Climate models can often predict that a heat wave is coming, but a number of factors, and how they interact, affect the strength and extent of a hot spell in sometimes unpredictable ways — as they did in Europe in 2003.

Trends observed by meteorologists and by Earth-orbiting satellites before that heat wave could have provided clues that summer temperatures would be abnormally warm, the researchers contend. The analysis focused on the Upper Danube watershed — an area surrounding Munich that is slightly smaller than South Carolina — but the results can be readily applied to larger areas as well, the researchers say.

The region began to suffer a pronounced drought in February 2003. Climate models suggest that by March, the soil moisture in the area's grasslands, croplands and forest dropped below normal and stayed there until May. Three different sets of satellite observations show the same trend: From early March to mid-May, the amount of moisture in the uppermost layer of soil declined an average of about 0.2 percent each day, the researchers report. Throughout 2004, 2005 and 2006, none of which had a heat wave, soil moisture was close to average.

Molecules

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

Plants reveal pollen-luring secrets

Molecules of attraction identified in the wishbone flower

By Rachel Zelkowitz

For more than a century, researchers have marveled at how pollen creeps down into a plant, growing a tube that twists and turns to reach the target ovary. But the nature of the siren song guiding this descent remained a mystery until now. For the first time, researchers have pinpointed the exact molecules one plant uses to attract pollen tubes to its reproductive organs.

The proteins, dubbed LUREs, can signal to pollen tubes in *Torenia fournieri* from as far away as 200 micrometers, the team reports in the March 19 *Nature*. While the proteins' role seems specific to this flower, the findings still represent a breakthrough in understanding plant reproduction, other researchers say.

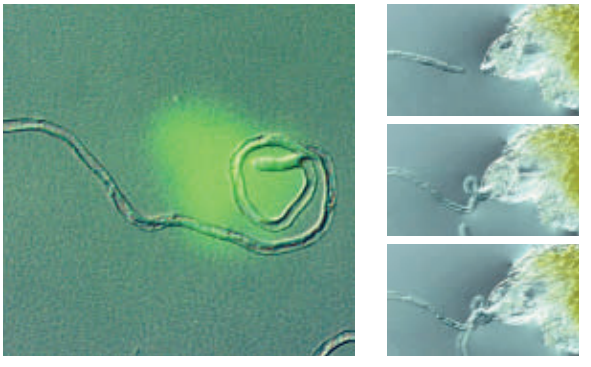
Scientists had long debated whether pollen tubes respond to chemical signals in the plant. By demonstrating the role of these proteins in this flower, "this paper really nails that point very clearly now," notes plant geneticist Mark Johnson of Brown University in Providence, R.I.

After landing on a flower petal, a pollen grain then has to grow a tube down a long cylinder called the style and locate the flower's ovary so sperm can move through and fertilize an egg.

T. fournieri, also known as the wishbone flower, makes a good model system because its ovaries, or embryo sacs, protrude from the base of the flower, Tetsuya Higashiyama of Nagoya University in Japan and colleagues note in the new study.

Previous research suggested synergid cells, which hug the embryo sac, direct the tubes once they approach the ovary. In the new study, the researchers surveyed more than 2,000 genes on synergid cells to identify which molecules lured pollen tubes to the embryo sac.

Molecules called cysteine-rich proteins, or CRPs, were most common on the synergid cells. Two of them, TfCRP1 and TfCRP3, effectively attracted pollen tubes, prompting the researchers to rename the proteins LURE1 and LURE2.



Proteins beckon
How pollen creeps down a plant to reach the ovary has been a mystery for more than a century. Now scientists find that, in the wishbone flower at least, proteins called LUREs (green fluorescence, left) in cells surrounding the embryo sac attract the pollen tubes. The tubes follow the chemical signal, growing toward the protruding embryo sac (right).

FROM LEFT: SATOHIRO OKUDA; T. HIGASHIYAMA (ALL THREE)

Light could heal material wounds

Chitosan-related compound allows coating to repair itself

By Rachel Ehrenberg

Sunshine may not cure all ills, but it could offer a quick fix for a scratched car. Scientists have used a substance from the shells of shrimp to create a new material that repairs itself when exposed to ultraviolet light. The properties of the polymer, described in the March 13 *Science*, are still being investigated, but it could someday make its way into coatings, such as paints, and into surfaces on everything from surgical instruments to countertops.

"It's some interesting chemistry," comments Nancy Sottos, a materials scientist at the University of Illinois at Urbana-Champaign. The self-repair market offers many potential applications, she says.

One approach to making self-repairing materials involves filling microcapsules or hollow fibers with a liquid healing agent and then mixing the capsules into a polymer-based substance. When the substance is damaged, the capsules break open and "bleed," healing the wound. Another approach is making a material with molecules that break and remake bonds through an interaction with an external stimulus such as heat, water or, in this case, UV light.

The key ingredient of the new material, created by polymer scientist Marek Urban and his doctoral student Biswajit Ghosh, is a dash of a precursor to chitosan, found in the shells of crustaceans such as crabs and shrimp. To the chitosan precursor, the scientists added oxetane, a ringed molecule that is easily broken. Then they incorporated the new OXE-CHI molecule into polyurethane.

Scratching the treated material breaks the oxetane rings, exposing reactive ends hungry to bind to something, explains Urban, of the University of Southern Mississippi in Hattiesburg. UV light cleaves the chitosan component, which then binds to the reactive ends made by the scratch.

Test scratches made with a razor blade healed after less than an hour of exposure to a 120-watt fluorescent UV lamp.

It is very difficult to tell just what's happening at the level of molecules, says Michael Kessler of Iowa State University in Ames. "Clearly, covalent bonds are being cleaved. And we know new bonds are forming."

Body & Brain

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

Gradual peanut exposure shows promise as an allergy treatment

Study shows some children can overcome their symptoms

By Nathan Seppa

WASHINGTON — Very gradual introduction of peanuts into the diet — starting with less than 1/1,000th of a peanut a day — may prevent allergic reactions to peanuts in some children, a new study finds. But the bit-by-bit strategy takes time and may not work in everyone, researchers reported March 15 at a meeting of the American Academy of Allergy, Asthma & Immunology.

In the longest study of its kind to date, the strategy of adding slightly more and more peanuts to a child's diet each day has enabled five children once allergic to peanuts to eat peanuts and peanut butter at will, says study coauthor Wesley Burks, a pediatric allergist and immunologist at Duke University Medical Center in Durham, N.C.

The strategy has enabled five children to eat peanuts and peanut butter at will.

Burks and his Duke colleagues teamed with scientists at the Arkansas Children's Hospital Research Institute in Little Rock to study 29 children who were allergic to peanuts. Each child initially received only microscopic amounts of peanut in a solution given at a research center.

After a few days, the children started getting tiny but ever-increasing amounts of carefully measured peanut powder at home, mainly sprinkled on their food. At the start of the study, the kids were 5 years old on average.

After eight months, some of the volunteers were able to eat 13 to 15 peanuts without having any allergic symptoms.

Nine of the children have been involved in the study for more than two years, and five of those nine appear to be free of peanut allergy even though they are no longer getting the treatment, Burks says. "They are putting peanuts in their diet," he says.

The other four from this initial group of nine have been slower to benefit from the gradual exposure, possibly because they had a stronger allergy to begin with, he says.

Data from the other participants will be available in coming months.

The two teams have begun a second allergy study in which five children receive this gradual peanut treatment and five others get a placebo. After one year, early results show protection in the treated children. This study is needed to help determine whether the strategy works.

"These are preliminary, small studies that are not yet giving us a final answer on the best treatment methods," says Robert Wood, a pediatric allergist at Johns Hopkins University in Baltimore. He thinks the approach holds promise, but he predicts that a daily treatment similar to this one might still be 10 years off.

This treatment was actually tried more than a hundred years ago but was set aside, says Scott Sicherer, a pediatric allergist at Mount Sinai School of Medicine in New York City. The new studies raise many questions, he says.

"Have we really cured the allergy, or are [the patients] just desensitized while they are getting the treatment?" he asks.

Nevertheless, the burden that a food allergy places on a family makes this treatment worth pursuing under scientific supervision, Sicherer says. "This is very encouraging, but it's not something you try at home." ■

NEWS BRIEFS

Organ rejection detection

Scientists have found a signature of organ rejection that could help detect and treat it before transplanted organs sustain damage, a team reports online March 16 in the *Proceedings of the National Academy of Sciences*. Manikkam Suthanthiran of New York–Presbyterian Hospital and Weill Cornell Medical College in New York City and colleagues uncovered a pattern of microRNA levels that distinguishes healthy transplanted tissue from tissue undergoing acute rejection. — *Tina Hesman Saey*

Cytomegalovirus vaccine

An experimental vaccine is effective half the time in stopping cytomegalovirus infection in women of child-bearing age, Robert Pass of the University of Alabama at Birmingham and colleagues report in the March 19 *New England Journal of Medicine*. Until now, no vaccine existed for the virus, which can cause birth defects when it infects a pregnant woman. — *Nathan Seppa*

Shallower brain stimulation

Getting a move on is difficult for people with Parkinson's disease. Deep brain stimulation has helped some patients, but no one was sure exactly how it worked. A study published online March 19 in *Science* shows that the technique exerts its effect on axons that feed into the subthalamic nucleus, rather than on the neurons in that structure. The finding suggests that less invasive procedures to stimulate parts of the brain closer to the surface might be an alternative to the deep brain surgery. — *Tina Hesman Saey*

Atom & Cosmos

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

Mars may host salty reservoirs

Brines could force physicists to rethink planet's history

By Ron Cowen

The Phoenix Mars Lander has been entombed in ice since November, but the salty tale it has told endures. The surprisingly high concentration of perchlorate salts found in the Martian polar soil last year — as much as a few percent by weight — could mean that shallow, extremely briny reserves of water lie just below much of the surface, researchers reported March 23 at the annual Lunar and Planetary Science Conference held in The Woodlands, Texas.

"There seems to be at least a possibility that we have liquid water in the near subsurface over much of the planet," says Christopher Chyba of Princeton University, who is not a member of the Phoenix teams. "That's a pretty startling change in the way we think about Mars."

Perchlorates can keep water liquid at temperatures as low as –68° Celsius, well below the average temperature at the Phoenix landing site last May, when the craft arrived in the arctic region.

Phoenix images taken early in the mission show what may be liquid droplets moving and merging on the legs of the craft, Nilton Renno of the University of Michigan in Ann Arbor and his colleagues reported at the conference. The droplets may have come from subsurface briny pools penetrated by the lander, Renno suggests.

Other Phoenix scientists, including Michael Hecht of NASA's Jet Propulsion Laboratory in Pasadena, Calif., argue that the blobs are likely frost, not liquid.

Regardless of the nature of the blobs, Hecht says he agrees with Renno about the possibility of briny pools. Such pools could force scientists "to go back and reexamine a lot of conclusions that we've reached about Mars," Hecht says.

The brines may explain the prevalence of salt-encrusted soil near the planet's equator and shed light on the possible movement of Mars' polar ice caps, the regulation of water vapor in the Martian atmosphere and the source of gullies found on the planet.

The high concentration of perchlorates is likely to exist across Martian soil, Hecht says. But the proposed perchlorate brines would be "too cold, too salty" to up the chances for finding active life on the planet, asserts Chris McKay of the NASA Ames Research Center in Mountain View, Calif.

Water necessary for gene replication and repair would be tied up in salt ions, adds David Des Marais, also of Ames. The highly saline water could, however, act to preserve vestiges of past life, he says.

It's possible that some kind of organism could extract energy by munching on the perchlorate as a kind of power bar, but the bacteria would have to have access to enough water to avoid drying up, Hecht says.

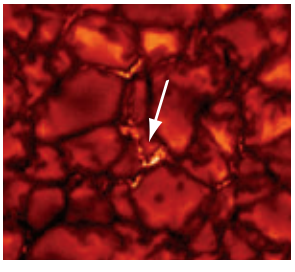
Team spots waves that heat corona

Find supports theory explaining why sun's atmosphere sizzles

By Solmaz Barazesh

Magnetic waves theorized to transfer heat from the surface of the sun to its outer atmosphere have been directly observed for the first time, a team reports in the March 20 *Science*.

Physicists have long wondered why the sun's corona, the outer part of the solar atmosphere, is millions of degrees hotter than its surface. "It's counterintuitive," says study coauthor David Jess of Queen's University Belfast in Northern Ireland. "When you hold your hands in front of a fire, it's hottest closest to the flames."



Scientists observed magnetic waves oscillating from a bright spot (arrow) on the sun's surface.

D. JESS

The magnetic waves, called Alfvén waves, are considered the most plausible explanation for the transfer of so much energy from the sun's surface to its corona. First theorized by Nobel laureate Hannes Alfvén in 1942, the waves could carry energy several hundred thousand kilometers from the surface.

The new observation "means that we can get to the root of what's heating the corona," says Craig DeForest of the Southwest Research Institute in Boulder, Colo.

Alfvén waves move along the sun's magnetic fields like "waves traveling along a string," Jess explains. The waves are created by magnetic reconnections — disturbances in the sun's magnetic field created when magnetic lines twist, break apart and then snap back together again.

Researchers have employed theoretical models to predict the waves' behavior. But in the new study, Jess and his colleagues used the Swedish 1-meter Solar Telescope to observe a highly magnetized bright point on the surface of the sun and measure the magnetic waves oscillating from that point. Data gathered by the team suggest that Alfvén waves are energetic enough to heat the whole corona.

"The next logical step is to measure how much energy the waves produce at different places in the sun's atmosphere to figure out if Alfvén waves are the dominant mechanism for heating the whole solar atmosphere," Jess says.

Physics

For longer versions of these and other reports from the meeting, visit **www.sciencenews.org/APSmarch2009**

Exotic state of matter shows up in ultracold gas of rubidium atoms

Supersolid acts like a solid and superfluid simultaneously

By Laura Sanders

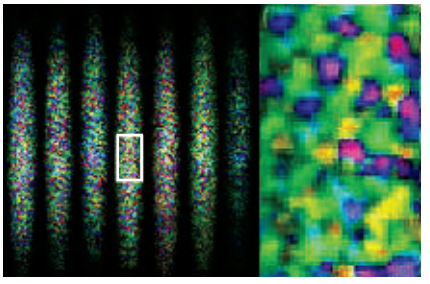
Hallmarks of an exotic, predicted state of matter called a supersolid have been spotted in a gas of ultracold rubidium atoms. In the same matter, researchers found signs of the seemingly disparate properties of both solidity and superfluidity, the frictionless flow of atoms.

Dan Stamper-Kurn described on March 18 two telltale signs suggesting that this weird matter may indeed be a supersolid. The new matter is "a gas, which is superfluid, and also shares properties of a solid," said Stamper-Kurn, of the University of California, Berkeley. If confirmed, a rubidium supersolid could help scientists better understand the properties of this strange state of matter.

"What we've seen is an ability to describe a peculiar state of nature," comments Paul Grant, a former visiting scholar at Stanford University and an IBM research staff member emeritus. If the researchers can extend their "interesting basic physics" to come up with new ideas and applications, Grant says, "there may be a Nobel Prize there."

A supersolid is defined by two seemingly contradictory properties. The atoms inside it are arranged in a crystalline, regular pattern, like any solid. At the same time, the atoms flow through the supersolid in an unrestricted way.

Although theorists predicted the existence of a supersolid more than three decades ago, the first observation came in 2004 when researchers at Pennsylvania State University found evidence for supersolid behavior by helium. The interpretations of those experiments are still being debated. Some researchers proposed that the impurities in the helium crystal, and not an intrinsic property, may cause the superfluid behavior.



MUKUND VENGALATTORE, D. STAMPER-KURN

Trapped in an elliptical formation, ultracold rubidium atoms self-organize into a regular crystal pattern (close-up right).

Stamper-Kurn and colleagues used magnets and lasers to trap rubidium atoms in a surfboard-shaped area. The team used the lasers to cool the atoms to temperatures around 500 nanokelvins, just above absolute zero.

At those ultracold temperatures, the rubidium gas exhibits a solid, crystalline structure, the team reports online at arxiv.org/abs/0901.3800. "There's some kind of distinct checkerboard pattern of magnetization that spontaneously forms," said Stamper-Kurn. Slight magnetism of each atom, called a dipole moment, may form the pattern, he said.

The researchers next checked for signs of superfluidity, measuring the rubidium crystal to see whether the atoms moved in a concerted way, called coherence. Using a technique called atom interferometry, the team found a zebra-striped interference pattern that could occur only if the atoms were in lock-step. This pattern was present over long ranges of the rubidium atoms.

"The coherence is required for superfluid flow. It provides the hallmarks of superfluidity," says Charles Clark of the National Institute of Standards and Technology's Joint Quantum Institute based at the University of Maryland in College Park.

MEETING NOTES

Quantum dots foe to algae

Nanomaterials keep slacks stain-free and sunscreens clear. But nanoparticles may also wreak havoc when they get into the environment. Priyanka Bhattacharya of Clemson University in South Carolina and her colleagues reported March 16 that quantum dots, a kind of nanoparticle, can decrease algae's ability to perform energy-producing photosynthesis. Blue-green algae exposed to high levels of quantum dots for three hours absorbed significantly less carbon dioxide and released less oxygen than did unexposed algae, said Bhattacharya. —*Laura Sanders*

Glass molecules twinkle

High-resolution images of glasses solidifying may help explain the precise conditions causing glassy materials to melt, reported Richard Wool of the University of Delaware in Newark on March 17. As glass goes from molten liquid to cool solid, its molecules slow but never completely stop.

Using atomic force microscopy, Wool's team took a picture every second for 512 seconds of an amorphous polystyrene hovering between the two states. The results support the "twinkling fractal theory" that Wool had proposed to predict the behavior of molecules in glass.

At the glass transition point, roughly half of the molecules are in the solid state, and crystalline clusters make a fractal pattern. As the molecules jump from solid crystals to liquids and back, the molecules' vibrational energies change. The molecules "twinkle," Wool said—a start for explaining how glass performs under heat. —*Laura Sanders*

Humans

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

Two cultures grasp music's universal feeling

Key, tempo clue Mafa in to emotion in Western tunes

By Bruce Bower

Cameroon's Mafa farmers don't know U2 from YouTube, and that's how they like it. So it comes as a scientific revelation that, according to a new study, these Africans who are largely cocooned from Western culture recognize expressions of happiness, sadness and fear in the same musical passages that Westerners do.

This finding provides the first solid evidence for a universal human ability to distinguish basic emotions in music, asserts a team led by Thomas Fritz of the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany.

"I was quite amazed that the Mafa accurately categorized basic emotions in pieces of Western music on the first listen," Fritz says.

His team's investigation indicates that Mafa and Western listeners similarly derive emotional meaning from the tempo and key of musical passages. Both groups tended to classify fast-paced pieces as happy and slow ones as fearful, and mostly agreed on which passages were sad, but assigned no particular tempo to them. Mafa and Westerners also generally regarded major-key pieces as happy, minor-key excerpts as fearful, and passages lacking an obvious key as sad.

Researcher Thomas Fritz (right) asked a Mafa man (left) to listen to musical pieces and describe their emotion in a recent study.

Mafa music exclusively expresses joy and happiness. Villagers play flutes made of iron, clay and wax at various rituals, including a harvest event. No word exists in the Mafa language for music, which is viewed as inseparable from ritual.

In another finding, both groups of volunteers preferred excerpts of Western and Mafa music to altered versions of the same excerpts that sounded dissonant, Fritz and his colleagues report in a paper to appear in the April 14 *Current Biology*. Western music often uses increasingly dissonant chords to build emotional tension, which gets resolved by returning to a consonant chord.

The new findings fit with earlier indications that people interpret certain acoustic cues in the same ways, comments Josh McDermott of New York University. Those earlier studies were focused on lab investigations of people who had previously heard Western music. Nonverbal elements of language that communicate emotion, such as rhythm and intonation, probably work similarly in music, in McDermott's view.

Stone tools from Zhoukoudian cave system

Peking Man ups his age

Peking Man has suddenly gotten much older. The *Homo erectus* fossils from China's Zhoukoudian cave system that are referred to collectively as Peking Man date to as early as 780,000 years ago, roughly 200,000 years earlier than previously thought, Guanjun Shen of Nanjing Normal University in China and his colleagues report in the March 12 *Nature*. Researchers first unearthed Peking Man fossils at Zhoukoudian in the 1920s. The site has since yielded 17,000 stone artifacts (some tools shown) and fossils from more than 50 *H. erectus* individuals. Along with revised dates for a handful of other Chinese *H. erectus* sites, the new evidence fits with the idea that *H. erectus* traveled to eastern Asia in two migrations. It also suggests that this ancient member of the human evolutionary family reached northeastern China at a time of relatively cool temperatures and inhabited the area throughout a series of shifts from cool and dry to wet and warm climates. —*Bruce Bower*

FROM TOP: T. FRITZ; RUSSELL CIOCHON/U. OF IOWA

Tennis Match Ends in FREE Love?

The 14-carat Lumiere Tennis Necklace comes with a matching 9 ½ carat Tennis Bracelet Bonus! But only if you read on...

"Seldom have I seen such an affordable necklace with so much fire and flashes of color"

— James T. Fent, Stauer GIA Graduate Gemologist

***Special Offer**

Tennis Bracelet Bonus

See details below.

Ever notice how much bling is showing up on the back court these days? Whether it's the red clay of the French Open in Paris or the green grass of Wimbledon, the lovely ladies of tennis are serving up some serious carats on the court. But unless you happen to be a Williams sister, the odds are good that those over-the-top diamond creations are a bit over your budget.

We don't think that the pros should have all the fun. So we assembled one of the most exciting tennis match-ups since the days of Martina and Billie Jean. We've paired our stunning Lumiére Tennis Necklace (over 14 carats of brilliant, lab-created Diamond*Aura*®) with our enormously popular Diamond*Aura*® Tennis Bracelet. Good enough? Not quite. That's why we dropped the price of the necklace by $200 and included the 9 ½ carat Diamond*Aura*® Tennis Bracelet... **as a BONUS** (a $195 value).

You can't be serious! We are. This pair features over 24 carats of dazzling Diamond*Aura*® luxury for under $299! Each brilliant-cut Diamond*Aura*® is carefully prong-set into the finest .925 sterling silver. The necklace sparkles with even more clarity and fire than natural mined diamonds, which in a similar design can sell for as much as $25,000.

A classic is born in competition. The beloved tennis bracelet earned its name after the "queen" of U.S. tennis lost her favorite diamond links during intense play at the 1987 U.S. Open. The match was halted so that Chrissie could collect her precious stones. From that day forward, the elegant inline diamond piece was known as a "tennis bracelet."

Since then, the style has become a sensation among the world's elite athletes and fashion superstars both on and off the court.

We've invested years of research and millions of dollars in perfecting Diamond*Aura*®, which has won the praise of noted jewelry experts around the world. According to the book, *Jewelry and Gems-the Buying Guide*, the technique used in Diamond*Aura* offers "the best diamond simulation to date." Our Diamond*Aura* jewelry retains every jeweler's specification: impeccable color, clarity, cut, and large carat weight.

Our 30-Love Guarantee. Not every jewelry purchase can be a match made in heaven. If you don't fall in love with the Diamond*Aura* Lumiére Tennis Necklace and BONUS matching Tennis Bracelet, return them within 30 days for a full refund of your purchase price.

JEWELRY SPECS:

- Over 14 ¾ ctw of Diamond*Aura*®
- .925 sterling silver settings
- 17" in length

*The Diamond*Aura*® Tennis Bracelet has more than enough bling to raise a racquet over— a $195 BONUS.*

Diamond*Aura*® Lumiére Necklace
(14 ¾ ctw) MSRP ~~$495~~
Your price **$295** +s&h

***Special Offer*—Receive the *DiamondAura*® Tennis Bracelet as a bonus with the purchase of the Lumiére Necklace.**

Call now to take advantage of this limited offer.

1-888-277-8382

Promotional Code DLN118-01
Please mention this code when you call.

Stauer
14101 Southcross Drive W.,
Dept. DLN118-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

By Ron Cowen

Mapping the earliest moments of time

Planck by Planck

Pssst!
Want to see the birth of the universe?

Astronomers say it's not a scam. The launch of the European Space Agency's Planck mission, set for late April or early May, will put into orbit a new tool — the microwave equivalent of polarized sunglasses — that may offer a view of the dawn of time.

Before the first galaxies, before the first stars, there was light — the brilliant glow of radiation created during the Big Bang, 13.7 billion years ago. The remnant of that ancient light, now cooled by the expansion of the universe to a frigid 2.7 kelvins, is known as the cosmic microwave background. Instruments on the Planck craft will explore this radiation in exquisite and unprecedented detail.

To minimize interference from Earth's own microwaves — which are 100 times more intense than the cosmic microwave background — Planck will orbit 1.5 million kilometers from the planet. It will take about six weeks to reach that orbit; once Planck settles in, its mission will last at least 14 months.

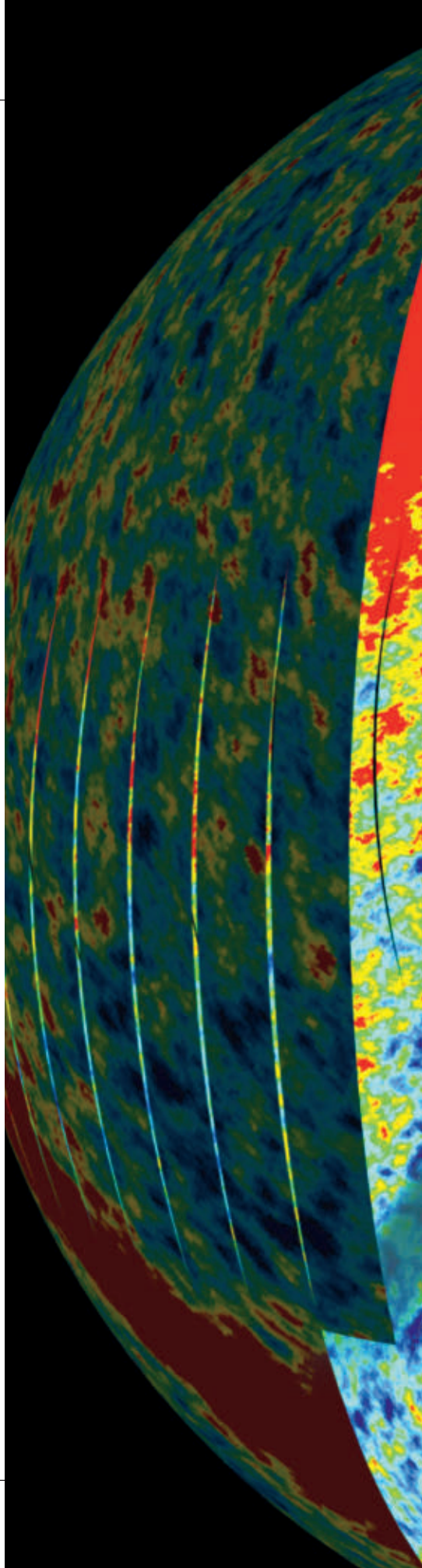
During that time, Planck will record temperature variations in the background radiation over a wide range of radio and microwave wavelengths. Its instruments are capable of measuring differences of less than a millionth of a kelvin.

Temperature blips at this scale were induced by tiny lumps in the otherwise smooth early universe. Those lumps gave birth to the cosmic tapestry observed today, a web of mammoth galaxy clusters strung along giant filaments separated by huge voids. By recording temperature variations more precisely than its predecessor in space, NASA's Wilkinson Microwave Anisotropy Probe or WMAP, Planck has the chance to measure the composition and shape of the early universe at a resolution 10 times better than any previous mission.

To detect these smallest of details, Planck will have some really cool instruments, with the most sensitive detectors chilled to within a tenth of a degree above absolute zero. The craft's 1.5-meter–wide telescope will focus radiation onto two sets of detectors, among the coldest ever to operate in space.

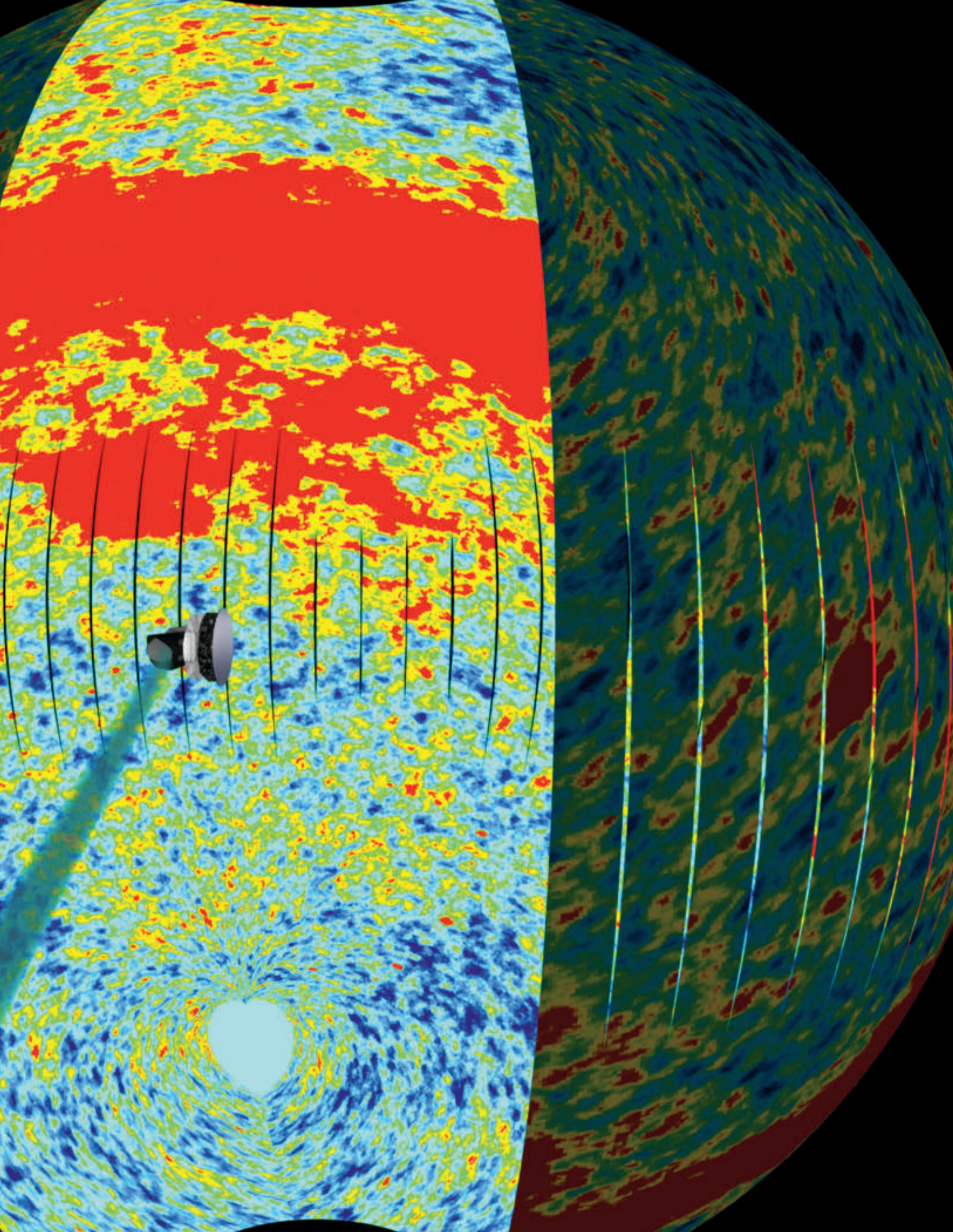
By recording microwaves over a wide range of frequencies, the two sets of instruments will more precisely sample the faint microwave background and more accurately distinguish it from the spurious microwave emissions of countless galaxies, including the Milky Way.

Planck's instruments can also detect signatures of polarized light from the microwave background. One of these



C. CARREAU/EUROPEAN SPACE AGENCY

Named for Max Planck (1858–1947), the German scientist who originated quantum theory, the Planck craft will sit between Earth and the sun and scan the entire sky in long, circular strips. Its mission is to detect tiny, potentially telling temperature variations within the cosmic microwave background, the radiation from the Big Bang. Shown is an illustration of Planck scanning that background, represented by its currently understood temperature profile (red for hotter regions and blue for cooler).



signatures would be a telltale sign of primordial gravitational waves, ripples in spacetime from the earliest moments of the universe. Finding those waves would give astronomers a glimpse of the universe as it appeared when it was only a trillionth of a trillionth of a trillionth of a second old. The most popular model of the birth of the universe, a theory called inflation, predicts the existence of these gravitational waves.

The simplest version of inflation suggests that the waves' amplitudes were large enough to leave indirect imprints on the microwave background, visible with Planck's microwave-tuned sunglasses. If Planck finds the imprint of those waves, "this would be the smoking gun for inflation" and a victory for cosmology, says theorist Michael Turner of the University of Chicago. Several ground-based telescopes are now racing to find the same polarization pattern, he adds, but Planck, "with its full sky and frequency coverage, seems to have the edge in the race."

Planck's secret weapons are bolometers, which record microwaves between the frequencies of 100 and 857 gigahertz. Fifty-two bolometers are part of one set of detectors, the High Frequency Instrument. It will pick up minute increases in heat — as low as a millionth of a kelvin — created when photons from the microwave background strike electrons in the device. The bolometers are sensitive enough to detect the different energies of the photons, and thus can measure the fine-scale temperature variation in the microwave background.

"Bolometers are the new kid on the block in space," providing both high sensitivity and spatial resolution for recording small temperature variations in the microwave sky, says Planck scientist François Bouchet of the Institute of Astrophysics in Paris.

Twenty of the High Frequency Instrument bolometers will detect the microwave background light regardless of its polarization; the other 32 will home in on polarized light, which travels in a vortex pattern.

Scanning the rest of the microwave spectrum is an array of 22 microwave receivers, similar to those used on WMAP but cooled to 20 kelvins by one of Planck's three cryocoolers. Known as the Low Frequency Instrument, this array will record the microwave background at relatively low energies, between 30 and 70 gigahertz, and all its receivers are set to detect polarized light.

Signs of inflation

Physicists are especially interested in gravitational waves because of their link to inflation, which is Planck's raison d'être. That theory was born in 1980 when a young theorist named Alan Guth, now at MIT, proposed that the universe underwent an unimaginably brief but enormous growth spurt immediately after birth. The baby cosmos ballooned from one billionth of a trillionth of a hydrogen atom's diameter to that of a soccer ball within just 10^{-35} seconds. Despite all the evidence supporting the theory, Guth wasn't sure how exactly inflation began. Nearly three decades later, theorists still don't know.

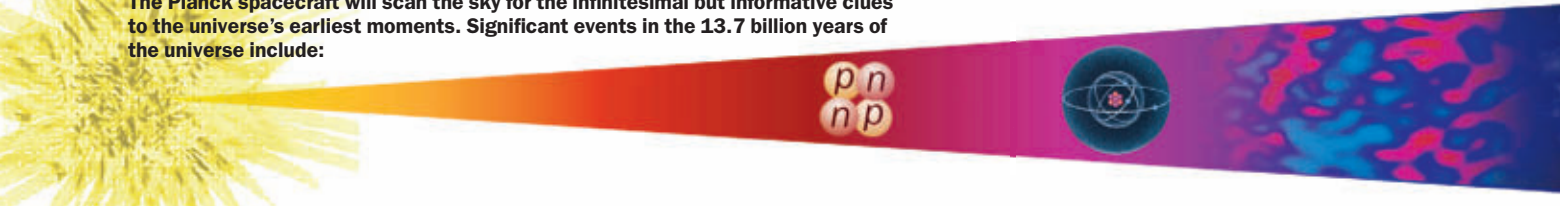
Inflation became popular, though, because it solves several problems. One problem is that on the largest scales, space is geometrically flat, even though Einstein's theory of general relativity would allow it to be curved. Another puzzle: Even though widely separated parts of the universe are too remote to have ever been in contact, they look remarkably similar, with galaxies clustering in the same patterns.

Inflation takes care of the first conundrum by stretching the universe so much that any local curvature of space from a concentration of mass flattens out. And by positing that the cosmos began as a tiny subatomic speck, with all regions initially in contact before inflating, the theory neatly explains why the universe looks so uniform from place to place.

If the idea is correct, inflation was triggered by an energy field called the inflaton that drove the early universe to rapidly expand, stretching out and freezing what otherwise would have been random, short-lived quantum fluctuations. Random quantum fluctuations in the inflaton

A glimpse of history

The Planck spacecraft will scan the sky for the infinitesimal but informative clues to the universe's earliest moments. Significant events in the 13.7 billion years of the universe include:



In the first second after the Big Bang ...

10^{-43} seconds
End of quantum gravity epoch

10^{-35} seconds
The electroweak and strong nuclear forces, once united, divide. Whether inflation began by this time or slightly after is an important question the Planck mission aims to answer.

10^{-11} seconds
The electromagnetic and weak nuclear forces, once combined as the electroweak force, divide.

10^{-6} seconds
Protons and neutrons form.

From one second on ...

3 minutes
Light elements such as helium, deuterium and lithium form. Hydrogen likely formed by this time.

380,000 years
Universe cools enough for neutral atoms to form and for cosmic radiation, previously too scattered by ions and free electrons, to begin streaming out.

field itself would have created spatial variations in the density of matter. Inflation would have stretched those variations to observable size.

Regions of the sky that today are separated by twice the apparent diameter of the full moon were once packed into a space much tinier than the diameter of a proton, inflation theory says. "Just the idea that you have the subatomic world projected on the sky today is mind-boggling," says Turner.

"If you want quantum fluctuations to explain all the structure in the universe, you need something like inflation," says Planck mission scientist Jean-Loup Puget of the University of Paris' Institute of Spatial Astrophysics in Orsay. "We want to see if this really works."

No one knows exactly when inflation started (or why it stopped) and what the earliest moments of the universe were truly like. That's where the prospect of recording gravitational waves by the Planck mission comes in. The gravitational waves are disturbances in spacetime itself, and are only stretched — not created — by the inflaton field.

Moreover, the soup of electrons and other elementary particles that filled the universe for its first 380,000 years would have posed no obstacle for gravitational waves. Unlike light, which remained trapped by this fog, gravitational waves zipped right through. These waves, some created a mere fraction of a second after the Big Bang, were free to leave their subtle imprint on the cosmic microwave background when that radiation began streaming into space.

As a result, gravitational waves have a simpler relationship to inflation than do fluctuations in the density of matter, says Turner. Finding evidence for gravitational waves would be a more direct indicator that inflation happened and of when it began.

Planck can't detect gravitational waves directly — that would come with space-based versions of experiments such as LIGO, the Laser Interferometer Gravitational-Wave Observatory (*SN: 1/8/00, p. 26*). But if their amplitudes are large enough, gravitational waves leave behind a detectable trail, one Planck is built to find.

The waves simultaneously stretch space in one direction while squeezing it in a perpendicular direction. This twisting forces the light to vibrate in specific directions as it journeys into space. In other words, the light is polarized. One of the polarization patterns induced by gravitational waves, called the E mode, is identical to that produced by density variations. But the other pattern, known as the B mode, has a swirling or vortex-like character that can be produced only by gravitational waves.

If Planck detects B mode polarization, it has detected the waves — and recorded something created during the earliest moments of the universe.

Planck "has the potential of making the first serious assault on the B mode polarization," says Turner.

That polarization pattern can be detected only if the gravitational waves are large enough. Inflation indicates that the strongest gravitational waves are those with the longest wavelengths. Their strength depends on how rapidly the universe expanded during inflation, and that in turn depends critically upon when inflation began.

The earlier inflation kicked in, the larger the waves' amplitude, says theorist Scott Dodelson of both the Fermi National Accelerator Laboratory in Batavia, Ill., and the University of Chicago. If the waves are amplified enough for Planck to detect, then inflation turned on sooner rather than later.

Timeline for the dawn of time

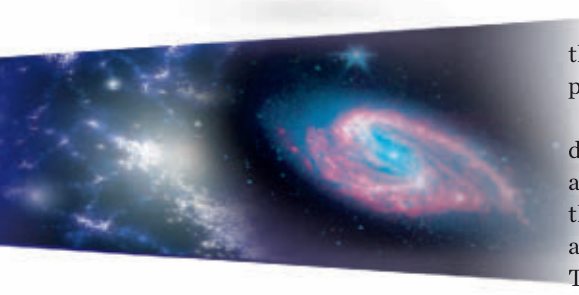
Trying to understand whether inflation began by 10^{-35} seconds after the birth of the universe or a tiny fraction of a second later may seem like an arcane endeavor. But finding out when inflation happened could help indicate why it happened. The energies of particles in the universe were higher at these hotter, earlier times, a trend with important implications for the fundamental forces of nature.

The standard model of particle physics insists that, when the universe was hotter than 10^{15} kelvins, the now-separate weak and electromagnetic forces were a single entity called the electroweak interaction. At earlier times, in the era of grand unification when energies were even higher, the electroweak interaction was united with the strong nuclear force. So whether inflation began at the time of grand unification or slightly later, when only the electromagnetic and weak interactions were unified, could determine how inflation was linked to the energy fields associated with particular elementary particles.

"Once you detect these gravitational waves, you will know with a one-line formula when inflation took place and what the energy scale of inflation is," says Turner.

Still, he adds, "it's going to be a very hard slog because there is not a single theorist that will stand out there and say, 'You'll have to find the gravitational waves at this level, otherwise I'll eat my Power Point.'" Planck's search for gravitational waves "is truly high-reward, high-risk physics," Turner says.

Although the microwave background was generated by the Big Bang, telescopes see the radiation as it appeared when it first streamed into space some 380,000 years later. Before that time, the universe was too hot for neutral atoms to exist; the radiation was relentlessly scattered by a cloud of ions and free electrons, the way a search light gets lost in a dense fog.



300 million years
Possible beginnings of first stars (*SN Online: "How a star is born," 7/31/2008*).

700 million–3 billion years
Galaxies form. Planck could help pin down when galaxies stopped clustering.

GRAPHIC BY J. KORENBLAT; IMAGES LEFT TO RIGHT FROM OPPOSITE PAGE: NASA POSTER, "WHAT IS YOUR COSMIC CONNECTION TO THE ELEMENTS?"; LITHIUM ATOM COPYRIGHT ADDISON WESLEY LONGMAN INC.; NASA, JPL-CALTECH, A. KASHLINSKY/GSFC; NASA, JPL-CALTECH, R. HURT/SSC; NASA, JPL-CALTECH, R. KENNICUTT/UNIV. OF ARIZONA, THE SINGS TEAM

Planck should provide further details on the early universe by detecting the polarization of the microwave background due to the variations in density. These density variations caused free-floating electrons to scatter the microwave background in a way that imparted the specific polarization patterns.

Those free electrons existed during two very separate epochs — the time just before the universe cooled enough for electrons and ions to combine into atoms, and at the much later time when starlight first flooded the universe with ultraviolet light and liberated electrons that had been bound to atoms.

By detecting this polarization, Planck will help pin down exactly not only when the universe first cooled sufficiently for neutral atoms to form, but also the time when the first stars were born.

This facet of the mission "is going to be a huge step forward," says Bouchet.

Hot (old) sounds

Even if Planck never finds the signature of gravitational waves, it still has a whole cosmic symphony to listen to. That's because sound waves and the cosmic microwave background go hand in hand.

Soon after the Big Bang, and until the universe cooled 380,000 years later, wherever gravity acted to draw matter in, the photons bound to that matter resisted and exerted an outward pressure. It's this tug-of-war between gravity's pull and radiation's push that generated acoustic oscillations — the cosmic equivalent of sounds.

Like any sound waves, these cosmic acoustic waves consist of a train of compressions and rarefactions — in this case traveling through the hot plasma of electrons and photons glued together within the young universe. The compressions heated the gas while the rarefactions stretched and cooled it. The waves imparted a pattern of temperature fluctuations into the radiation. The pattern persisted even as the universe cooled and the freed radiation journeyed into space.

By measuring peaks in cosmic microwave background temperatures on a host of different spatial scales, Planck will record this primordial symphony as never before. Just as musicians can discern the nature of a violin by listening to the richness of its tones and overtones, cosmologists can examine the highs and lows in the temperatures of the microwave radiation to discern the properties of the universe: its age, how much dark matter and ordinary matter it contains, how fast it's expanding.

NASA's WMAP, launched in 2001 and still collecting data, studied the first few of these peaks across the full sky. A slew of ground-based telescopes have examined these peaks over more restricted portions of the sky. But by measuring the higher overtones, Planck will shrink the number of allowed models for the birth of the universe and provide new insight into the physics that debuted during the first billionths of a second after the Big Bang, says Puget.

Good noise

As a bonus, the data Planck collects may also provide new information on dark energy, the mysterious substance that flips gravity from a cosmic pull into a cosmic push and causes the universe to expand at an ever-faster rate (*SN: 2/2/08, p. 74*).

Once dark energy becomes strong enough to accelerate cosmic expansion, galaxies can no longer congregate into clusters. Understanding how early — and how quickly — galaxies formed clusters could shed light on the nature of dark energy and whether it has remained constant over the lifetime of the universe. And Planck can help answer that question using information that it was designed to discard.

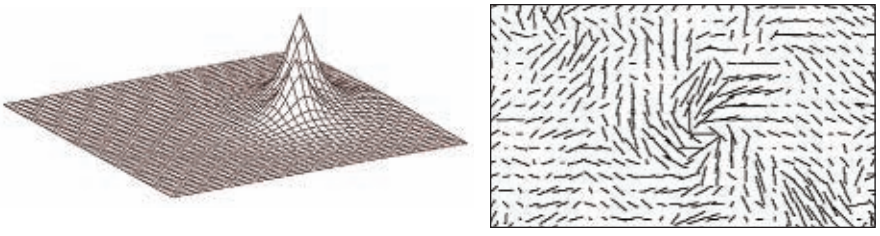
To clearly view the cosmic microwave background, Planck will record and eliminate foreground sources — emissions from the Milky Way and other galaxies. But one man's noise is another man's data. For some astrophysicists, the discarded information is a gold mine. It could reveal the magnetic structure of the Milky Way, radio emissions from a host of nearby galaxies and several remote ones, and the evolution of galaxy clusters. The last could be particularly intriguing in shedding light on dark energy.

Still, for many cosmologists, Planck's main goal — "pinning down the parameters of the physics which produced inflation" — remains paramount, says Dodelson.

"You can't dream of building an accelerator big enough to detect any of those parameters," he notes. The world's biggest atom smasher, the Large Hadron Collider near Geneva, is set to resume operation in the fall, about the same time Planck begins gathering data. Yet the energies available at the LHC are only one-trillionth the level Planck will probe in looking for the signal of gravitational waves, Dodelson says, adding: "That we can hope to learn anything at all about the energy scale when the universe began is unbelievable." ■

Memories of stretched gravity

Below at left is a simulation of a tiny primordial gravitational wave being stretched to macroscopic proportions by inflation. At right is a simulation of the patterns of polarized light that would remain in the cosmic microwave background today because of this stretching.



GRAVITATIONAL WAVE: S. DODELSON; POLARIZATION PATTERN: W. HU

Explore more

- Visit the European Space Agency's Planck website: tinyurl.com/e8kvv
- Cosmic microwave background primer: background.uchicago.edu

Summon Emergency Help Immediately

"This pendant saved my life."

Exclusive ***Designed For Seniors***™ MedicalAlarm is a life-changing, lifesaving solution. Help when you need it ***most***:
Medical Emergency – Accident – Fire – Burglary

NEW

FREE Shipping

3 FREE adapters for pendant, belt, or wrist

Simple

- No contract
- Large buttons
- Easy 5 minute setup

Reliable

- 48 hour battery backup
- 24/7 monitoring
- Lifetime warranty
- Waterproof pendants

Affordable

- Free equipment
- Free activation
- Lowest monthly rate
- Second user – FREE

Dear Friends,

At Designed For Seniors™ MedicalAlarm, we have the simple notion that it's possible to provide great care, great service, and peace-of-mind --- affordably --- for Seniors all across America. Unlike other companies we've eliminated all the up front costs related to our service… no equipment to buy/rent, no activation fee, and no contract. Our monthly fee is the lowest available – plus a second user in the same household is always ***free.***

How it Works. In an emergency, push your button, which sends a wireless signal to your medical unit allowing it to contact us toll free. Within seconds you will hear the reassuring voice of a member of our highly trained monitoring staff through the "whole house" two-way intercom unit attached to your home phone. We check on your status and dispatch your local Emergency Medical Services and/or the needed assistance of a nearby friend, neighbor, or family member. And, because no one likes to be alone in an emergency, we maintain voice contact with you until someone arrives!

"Peace-of-mind" that is always on! We believe our policies and concerns for our clients set us apart from other companies. We provide you with the highest rated equipment on the market today, combined with the reliability and precision of our state-of-the-art monitoring center. You will even have a personal Life Safety Representative that you can call with any questions or concerns. We provide a service that is unparalleled and we NEVER compromise when it comes to your safety! Our entire staff from the sales team to technical assistance will treat YOU as if you were their own loved one… and that's a promise!

firstSTREET for Boomers and Beyond®
1998 Ruffin Mill Road
Colonial Heights, VA 23834

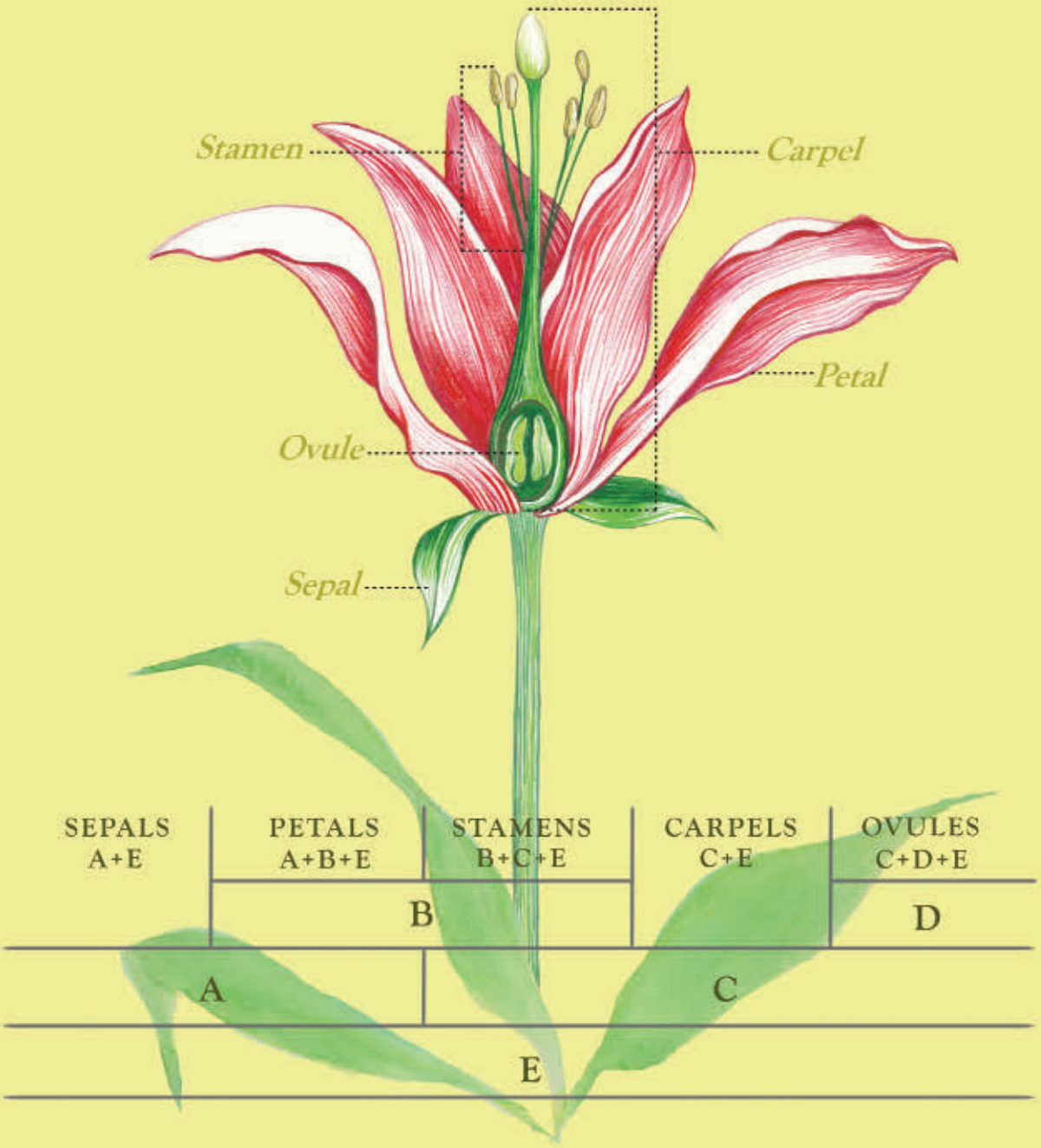
Call now for more information on how the Designed For Seniors™ MedicalAlarm can keep you safe, and save you money!

1-877-391-0559

Please mention promotional code 37991 for FREE *Shipping.*

www.DesignedForSeniors.com

56759



The ABC model of floral development *emerged in the late 1980s from research on flowering plants with genetic mutations. The model originally described three classes of mutant plants, linking genes categorized as A, B or C to predictable mistakes in flower structure. A flower normally is made up of four concentric layers, or whorls, of parts: sepals form the outermost whorl, then petals, stamens and carpels. In plants without functioning A, B or C class genes, floral organs developed in the wrong whorl or didn't develop at all. The revised ABC model, shown above, includes two additional classes of genes (D and E). It shows how the genes work in various combinations to trigger the specialization of tissues into the whorls of a flower. A and E class genes are needed to make sepals; A, B and E for petals. To make stamens, B, C and E genes are active. C and E are required for carpels, and C, D and E for ovules inside the carpels. The model has held up well, but may change as scientists probe floral development in more species.*

Building Beauty

Deconstructing flowers yields the secrets of petals, scents and hue

By Rachel Ehrenberg
Illustration by Gina Mikel

Flowers are essentially variations on a single theme: Come hither. Instead of lipstick and lace, flowers advertise with vivid petals and ultraviolet stripes. Some plants offer a legitimate exchange of goods — visitors are rewarded with protein-rich pollen or sweet nectar. Other flowers deceive, mimicking the scent, color and feel of a rotting carcass to entice carrion flies looking for a suitable place to start a family. Even plants pollinated by the wind dress for success, taunting the air with copious, lightweight pollen.

Beneath all the superficial charm of flashy petals or intoxicating scents is the serious business of sperm and eggs, reproduction, the continuance of the family line. Flowering plants excel at being fruitful and multiplying (heck, they invented it). Although they are evolutionarily younger than their nonflowering relatives, the flowering plants — aka the angiosperms — are far more successful, conquering every continent and diversifying into some 250,000 species. Their evolution is credited with altering Earth's landscape in a way that allowed the rise of other life, such as insects, mammals and eventually primates.

Today people use flowers to woo, apologize or express sympathy or blessings. And, of course, people eat them. Flowers that have matured into fruits provide nearly 70 percent of human food. Rice, wheat, beans and corn are all technically seeds from fruits — the end point, and point of, flowers. Given what's at stake, it's not surprising that plants construct such elaborate advertisements — or that scientists are bent on figuring floral structures out. Such research could lead to improved crops, designer scents or novel compounds for drugs.

Recent genetic and molecular studies suggest there's a curious simplicity underlying a flower's structure — although ongoing work keeps adding new twists. Flowers' wide array of petal designs, scents and colors appears to stem in part from a rich genetic toolkit that gives plants developmental flexibility. Many flowering plants use the same basic genes to direct the development of petals, though the control of other floral parts appears more complex. Investigations of scent compounds also implicate multiple copies of identical or closely related genes — exemplified by work detailing how some roses lost their namesake fragrance. The complexities of color are also being unraveled. For example, scientists are looking beyond pigments to learn how metals, cell shape and pH may give flowers the blues.

Floral ABCs

Plants are extremely opportunistic — stick a leaf from a jade plant in some sand and it may sprout roots. The roots may grow a shoot and, with the right light, the shoot may grow flowers (imagine planting a piece of tail and growing a squirrel). That capacity reflects an enormous developmental flexibility, one that sets plants apart from animals, says Beverley Glover of the University of Cambridge in England.

"A zoologist would say that plants have to have this flexibility to cope with the design flaw of being sessile, staying in one place," says Glover. "I would argue that animals need mobility to cope with the design flaw of a limited genetic and developmental program."

Plants' flexibility appears to arise from a genetic pantry that's extremely well-stocked. The genomes of some plants are outrageously large: The book of genetic instructions for the ornamental lily *Fritillaria* is nearly 40 times the size of the human genome. And many plants have multiple copies of identical or closely related genes.

When petals are made, "It is the same sorts of genes doing the same things in a slightly different way," Glover says. "Maybe I am naive, but I think it is surprising."

Flowers have four concentric whorls of parts: sepals on the outside, then petals, then stamens and carpels at the center. In the 1980s scientists working with mutant plants — Enrico Coen with snapdragons and, independently, Elliot Meyerowitz with *Arabidopsis* — described how three classes of genes (A, B and C) orchestrate the correct development of these floral parts. Called the

ABC model of development, the idea hearkened back to a concept put forth in 1790 by German poet Johann Wolfgang von Goethe, who in botanical circles may be as famous for leaves as he is for *Faust*. His treatise on plant metamorphosis proclaimed, "All is leaf."

Two hundred years later the notion that sepals, petals, stamens and carpels are all modified leaves got its molecular validation. Both Coen and Meyerowitz noticed that in plants in which certain genes were disabled, some floral organs were made in the wrong place or weren't made at all, and in some cases, leaves were made instead. Plants missing A class genes, for example, did not grow petals. B class mutants didn't grow petals or stamens, instead developing two whorls of sepals and two of carpels. The model, since expanded to include D and E class genes, predicted that mutant plants would have particular variations on the normal floral arrangement, predictions that have largely been borne out by research. Yet snapdragon and *Arabidopsis* are but two of thousands of flowering plants. So researchers are still probing where the model holds up and where there are variations on the ABC theme.

New work investigating flower building in the buttercup family backs up the role B class genes play in petals, overturning some long-held beliefs about the family's dizzying array of floral forms, says Harvard University's Elena Kramer.

The buttercup family includes delphinium, monkshood, anemone and columbine. Looking at the family tree, it appears that petals have been lost and gained many times in this group's evolution. And many of the flowers in this family have a second, inner whorl of petals that look suspiciously like modified stamens, a flower's pollen-bearing male structures. Then there are the sepals, which in many plants are green and diminutive. Not so in the buttercups, many of which have glammed up their sepals with pigments and nectar spurs.

Still, in the January *American Journal of Botany* Kramer reports that no matter the size, shape or color, buttercups and their relatives all recruit the same genes to direct the development of petals.

"Perhaps there aren't so many ways to skin a cat," says David Baum of the University of Wisconsin–Madison.

It isn't clear which genes lead to the stamenlike petals, Kramer notes. And the outermost whorl, the sepals, remains a puzzle. When this outer whorl becomes showy and petal-like, as in delphinium, it sometimes recruits petal genes. But that's not so in other plants, such as asparagus, suggesting the ABC model will continue to be revised.

"What's going on with sepals is anybody's guess," Kramer says.

Chemical billboards

Ostentatious petals or sepals are just one asset in the portfolio of floral attractants. Smell lilacs, jasmine or a lily and it's clear that plants also advertise through the air. Plants manufacture a huge repertoire of chemicals: The structures of nearly 50,000 plant compounds have been elucidated, says David Gang of the University of Arizona in Tucson.

Besides helping to attract pollinators, metabolic compounds may ward off grazers, defend the plant from fungi or suppress the growth of neighboring plants.

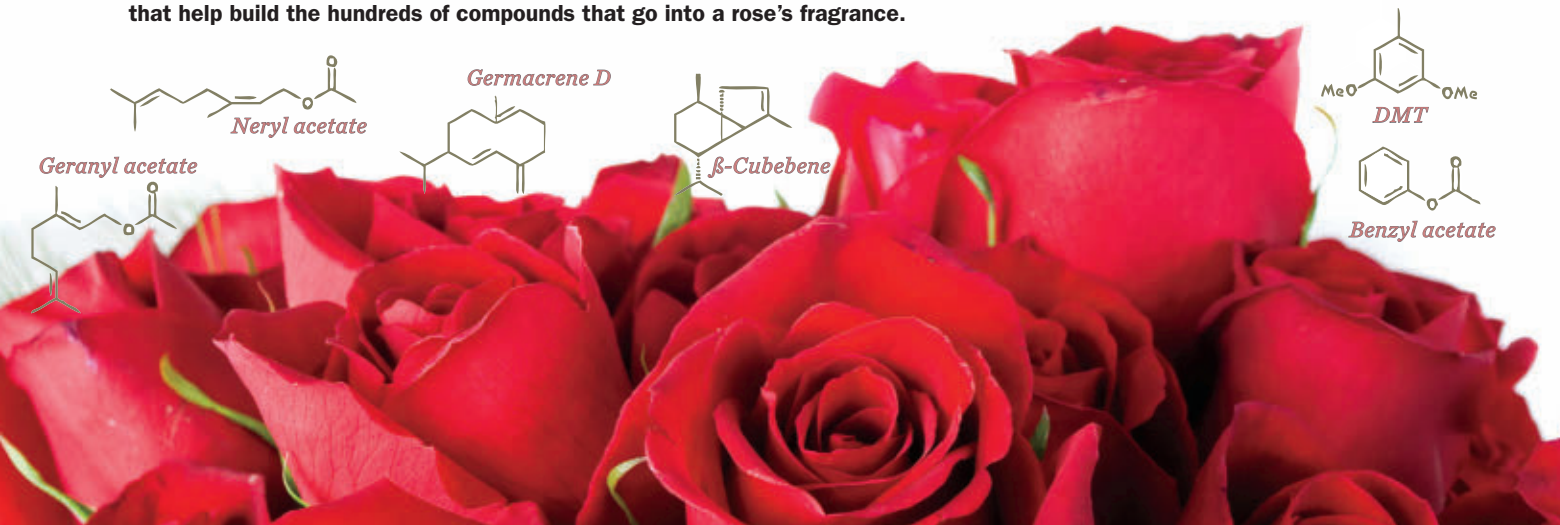
"Plants can't get up and run away," says Gang. "So they can make things like spines to defend themselves, or they can make poisons." (Gang's enthusiasm prompts visions of plants with a wary eye on their surroundings — stinging hairs cocked, cyanide at the ready.)

Some plant biochemical pathways — the series of chemical reactions that generate these compounds — are extremely ancient. The floral scent pathway that produces terpenoids (a large class of aromatic chemicals) is also present in animals and fungi, Gang notes. Most enzymes — the proteins that work on the assembly line as molecules go by (add a sugar, take off a methyl group) — in these paths are very similar across the plant kingdom. But look at the enzymes farther along the scent pathway and the diversity explodes, says Gang.

Scientists believe much of this diversity has arisen through duplications of the genes that encode enzymes in the scent pathways. A duplicated gene may accumulate mutations that give it a slightly different function than the original gene. The result can change the scent produced by the biochemical pathway. This appears to have happened in modern roses, scientists reported last year in the *Proceedings of the National Academy of Sciences*.

Roses have long been recognized for their fragrance — some 300 to 400 compounds go into a rose's scent. Many modern roses result from extensive breeding

Stop and smell the roses: Scientists are zeroing in on the genes and enzymes that help build the hundreds of compounds that go into a rose's fragrance.



ADAMKAZ/ISTOCKPHOTO; SOURCE: GANG/*ANNUAL REVIEW OF PLANT BIOLOGY* 2005

of two main lines: European varieties, which contributed resistance to cold and pests, and Chinese varieties, which contributed repeated flowering. Each variety also contributed its characteristic scent. (Never mind Juliet waxing about them smelling as sweet, no matter the name.)

"One of the big things that happened when we domesticated roses is we eliminated scent," says Gang. "The ones you find in a garden with the most fragrant smells have very few petals but smell heavenly."

Damask roses, a common European variety, are typically thought of as rose-scented, says Gang. Their fragrance is dominated by rose oxide, a compound prized by the perfume and flavor industries. But the modern tea roses that dominate the coolers of florists across the United States are a hybrid of the European and Chinese varieties. They often smell more like tea than eau de rose.

A major contributor to the tea aroma is a compound known as 3,5-dimethoxytoluene, or DMT. Two related enzymes, known as OOMT1 and OOMT2, are responsible for the reactions that produce DMT. Due to a gene duplication event, Chinese roses have both OOMT1 and OOMT2. European varieties have only OOMT2, which isn't active in their petals. This means that European roses smell like, well, roses. Hybrids, on the other hand, inherited both OOMT enzymes from their Chinese relatives and so produce the DMT-tea odor.

The study is a nice example of how a single duplication event can lead to big changes in scent, says Gang. And figuring out the details of the duplication may lead to new rose varieties that smell as sweet as their name.

"We're at a point where perhaps we could rebreed the rose scent back into the flowers with all the petals," he says.

Blooming blues

While tantalizing perfumes and artfully arranged petals do their part to attract, something's got to grab the attention of a pollinator from afar. Studies suggest that visual cue is often color. Just

IMAGE PLAN/CORBIS

Metals, pH and cellular architecture all can contribute to floral blues.

three major pigments are responsible for most of the color seen in flowers: betalins, carotenoids and anthocyanins.

When orange, red, blue or purple flowers catch your eye, it is most likely the work of the anthocyanins. These pigments are well characterized and often have other functions, such as acting as a sunscreen in leaves. So flower color can be strongly affected by what's happening elsewhere in the plant — genes in charge of cranking up an herbivore deterrent in the leaves may yield flowers of a different shade, for example, says Mark Rausher of Duke University in Durham, N.C.

In a May 2008 paper in *Evolution*, Rausher and coauthor L. Caitlin Coberly reported that, in the common morning glory, versions of a gene that encode for white flowers are favored in some populations. Yet white flowers never dominate in these populations, perhaps because shutting down the flow of purple pigment in flowers would also shut down the pathway in the rest of the plant. This could hinder other important functions provided by the pigment, including protection from UV light and interactions with helpful soil fungi, says Rausher, who also explored trends in floral color shifts in a 2008 paper in the *International Journal of Plant Sciences*.

The local pigment environment — the architecture of the pigmented cells or their pH — also affects how pigments are perceived from outside the flower, evidence suggests.

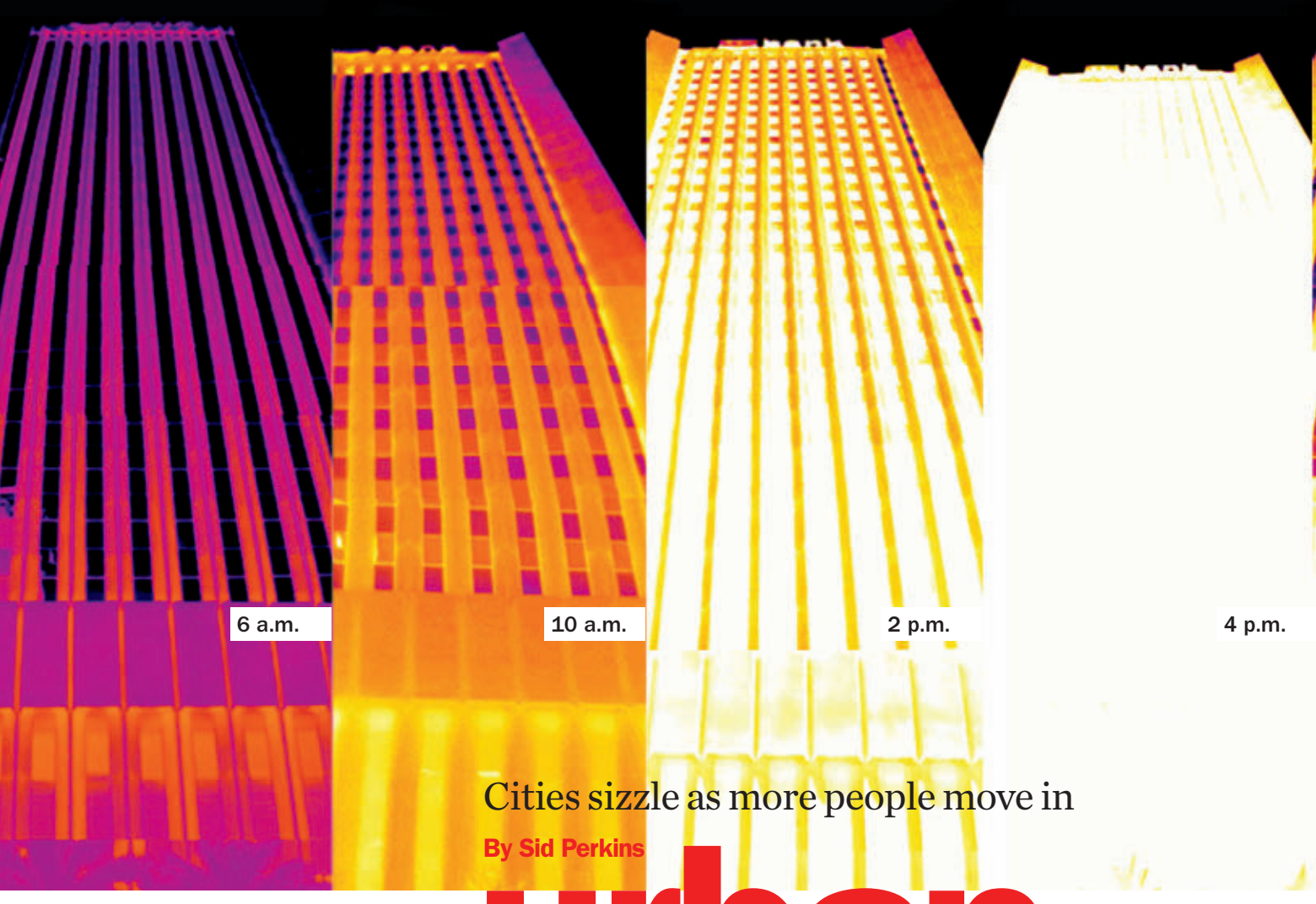
For example, the rose cultivar Rhapsody in Blue changes from red-purple to bluish-purple with age. This shift in hue results from the accumulation of anthocyanins in petal cells. Similarly, in 2007 Glover and her colleagues reported in *Arthropod-Plant Interactions* that a mutation altering the surface cells of a snapdragon's petals shifted light's path within the pigment cells, making them appear pink rather than purple. And in more alkaline conditions, pigments in some red or pink flowers become blue.

Recent work also implicates metals in the path to the blues. In 2005 Japanese scientists reported that iron, magnesium and calcium work together with the plant compounds anthocyanin and flavone to produce the blue of cornflowers. Another group in Japan has shown that the sky blue of Himalayan poppies, *Meconopsis*, results from the bonding of iron and magnesium to an anthocyanin and a flavenol. The blue of the dayflower, *Commelina*, comes from a complex formed by magnesium, anthocyanin and flavone, a team reported last year. And the blue hue of hydrangeas is due in part to the buildup of aluminum in the sepals. The metal is less available in more alkaline conditions, so for pinker flowers gardeners can add lime, which is highly alkaline, to the soil.

Advances in understanding flower color will undoubtedly continue to emerge — the market for ornamental plants and cut flowers totals over $70 billion annually in sales, and the generation of new colors is a hot area of research for the industry. New fragrances — not only from flowers, but also leaves (such as new varieties of sweet basil) — are also being explored, and some of the investigated compounds hold promise as potential new drugs. As scientists come closer to deconstructing flowers, they will undoubtedly get better at constructing them as well. But nature's got a good lead — one that will be hard to beat. ■

Explore more

- Beverley Glover. *Understanding flowers and flowering: an integrated approach.* Oxford University Press, 2007.



Cities sizzle as more people move in

By Sid Perkins

Urban heat

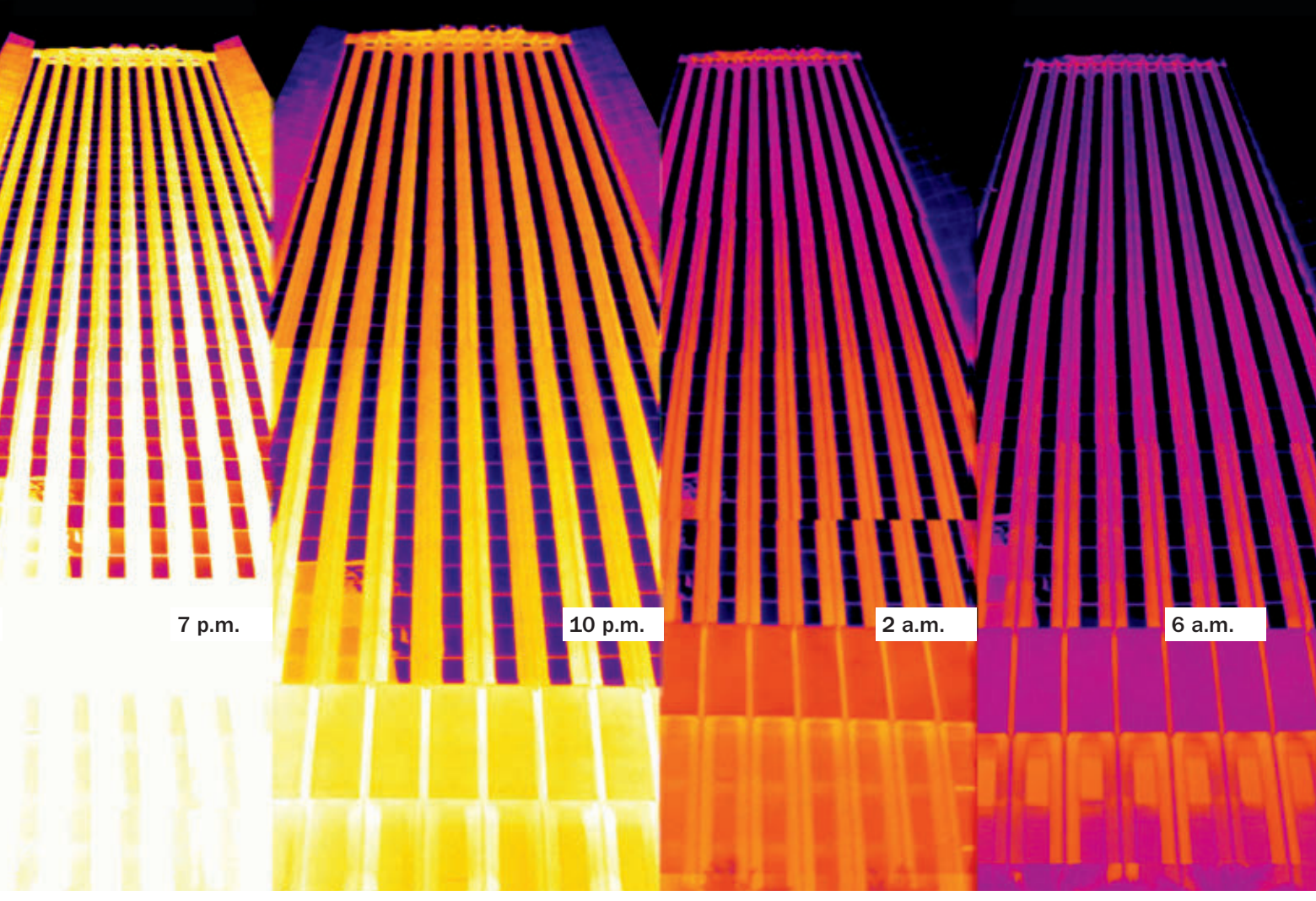
In life, as in boxing, the combined effects of a one-two punch are often more devastating than either blow alone. Imagine, then, the devastation from a triple whammy that city dwellers might suffer this century as three unfavorable trends converge to afflict an already warming world.

First, there's temperature. According to the Intergovernmental Panel on Climate Change, Earth's average global temperature has risen about 0.74 degrees Celsius in the past century (*SN: 2/10/07, p. 83*), an increase almost certainly linked to the rising concentrations of carbon dioxide and other heat-trapping greenhouse gases that human activities have released into Earth's atmosphere. IPCC scientists suggest this warming trend will continue, and indeed accelerate: In the next 20 years, average global temperature will rise another 0.4 degrees C or so, they estimate.

Then, there's population growth. Now home to more than 6.6 billion people, Earth will see its population increase by about 25 percent, or 1.65 billion, by the year 2030 (*SN: 10/13/07, p. 235*). Even with substantial increases in energy efficiency, this dramatically larger population will likely trigger a rise in total energy consumption, further boosting emissions of greenhouse gases.

Third, there's urbanization. Much of the world's population growth in coming decades will occur within cities, where residents are exposed to warmer-than-average conditions due to the "urban heat island" effect. People living in large, well-developed areas typically experience temperatures several degrees warmer than do residents of the rural areas nearby.

The confluence of these trends could create a "perfect storm" that places urban dwellers at increased environmental risk, says Walt Dabberdt, president of the American Meteorological Society in 2008. Besides the risk from



DI SABATINO *ET AL.*/ARIZONA STATE UNIVERSITY

A one-day, round-the-clock thermal study of Phoenix buildings, including the U.S. Bank Center, tracked how concrete and glass absorb heat by day and release it by night. Deep purple is 9°C, deep orange is 17°C and white is at least 25°C. Throughout the night, the building, especially near street level, remained warmer than the surrounding air.

rising sea levels — much of the projected population increases will be in coastal cities — urban dwellers could be exposed to more-frequent heat waves, higher levels of pollution and a myriad of health concerns (*SN: 7/3/04, p. 10*).

Possibly of more importance, much of the population growth will result in urban sprawl in what are now smaller metropolitan areas — a trend that will lead to dramatically larger numbers of people living within urban heat islands.

Future changes in climate, as well as the effects of those changes on regional and local weather, must be an integral part of urban planning, Dabberdt notes. The way urban heat islands affect climate overall is also important: If more people move to places that require increasing amounts of air conditioning, even more greenhouse gases will be emitted.

"Cities are major contributors to anthropogenic climate change," says Dabberdt, who is also the Boulder, Colo.–based chief science officer for Vaisala Corp., an international manufacturer of weather-monitoring systems and instruments. Overall, he says, urban areas are directly or indirectly responsible for about 80 percent of the emissions of planet-warming greenhouse gases such as carbon dioxide. While many of those emissions are produced in the cities by industrial activity or vehicles, others are generated in coal-fired power plants that are far from the cities but are still driven by urban demand for power.

The topic of urban heat occupied many researchers who gathered in January for the 2009 annual meeting of the American Meteorological Society, held appropriately enough in Phoenix, the site of many recent studies of the urban heat island effect. While some scientists are studying how to minimize the temperature-boosting effects of urban heat islands, others are studying how urban dwellers can substantially reduce the amount of greenhouse gases that are emitted in the first place.

From farm to suburb

People have been living in increasingly large settlements ever since they gave up the hunter-gatherer lifestyle and began to cultivate the land. As agriculture became more efficient, urban populations could grow — a trend that accelerated with the Industrial Revolution and is continuing today as technology allows an ever-smaller fraction of the population to feed everyone else, says Kai N. Lee, a political scientist at the David and Lucile Packard Foundation in Los Altos, Calif.

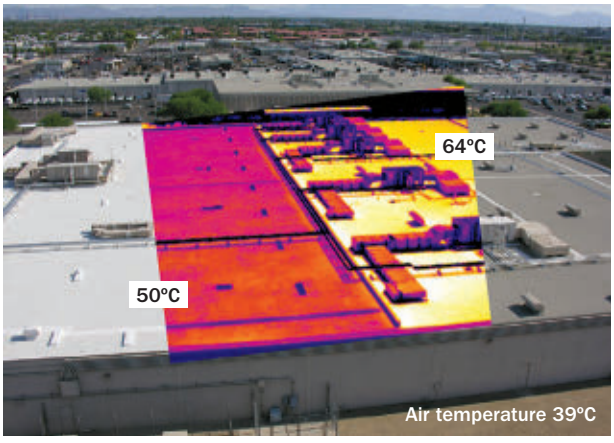
For example, in 1740, about two-

thirds of the labor force in England and Wales — the birthplace of the Industrial Revolution — worked in agriculture. A century later, as labor-saving machines proliferated, that fraction had fallen to less than one-quarter, and England was exporting surplus food to boot, Lee notes. Today, in developed nations, less than 5 percent of the population engages in agriculture, he says.

As that proportion has fallen, the percentage of urban dwellers has risen, Lee said at the AMS meeting. In 1800, only about 2 percent of the world's population lived in cities. In 2007, for the first time, that fraction rose above 50 percent, and it's poised to grow even more. While in raw numbers the world's rural population is now at its peak and will probably decline slightly in coming years, urban population will continue to grow at a brisk pace. According to estimates by United Nations demographers, more than 60 percent of the world's population will live in urban areas by 2030.

Most of that growth will take place in rapidly developing nations such as China and India and in regions such as Sub-Saharan Africa, which is already home to more urban dwellers than the combined populations of the United States and Canada, says Lee.

And the bulk of urban growth — which by 2030 will tally about 1.3 million people per week worldwide — will occur in cities that now hold less than 500,000 people. That trend will expose increasing numbers of people to urban-accentuated heat: While recent research suggests that the urban heat islands in large, long-established cities haven't strengthened in recent decades (*SN Online: "Don't blame the cities," 9/5/08*), temperature differences between urban and rural areas in rapidly developing regions such as eastern China have increased substantially as its cities have sprawled and developed.



A thermal perspective of a sun-soaked rooftop in a Phoenix suburb reveals that gravel painted bright white (left) remains cooler than darker gravel (right).

Cooking by day and night

In one sense, urban heat islands have been around as long as urban areas have: They just started out small and grew as cities did. Buildings and pavement typically are made of materials that have a lower albedo — that is, they absorb more of the sun's radiation than does the natural landscape — and, during the daytime, reach higher equilibrium temperatures than surrounding objects do. At night, the buildings and streets release much of that heat. The boost in both daytime and nighttime temperatures raises the average temperature in the city.

Another often unrecognized factor that boosts urban temperatures is the proliferation of impervious surfaces, says David J. Sailor, a mechanical engineer at Portland State University in Oregon. As the proportion of rain-shedding surfaces such as roofs, pavement, sidewalks and streets goes up, the water that previously would have soaked into the ground — and later would have soaked up heat as it evaporated — simply drains away into sewers or streams (*SN: 9/4/04, p. 152*). Areas swaddled with impervious surfaces, in essence, heat up because the ground has lost its ability to sweat.

The size, shape and arrangement of buildings, particularly in a downtown core dense with skyscrapers, can also influence urban temperatures, Sailor said at the AMS meeting. If the heat-soaked facade of a tall building can't "see the sky" at night — in other words, if it is surrounded by other tall buildings — any heat it gives off at night ends up warming nearby buildings rather than radiating back into space.

Finally, says Sailor, human activity generates immense quantities of heat. Burning a kilogram of gasoline generates about 45 million joules of energy, enough to melt 60 kilograms of ice and bring it to boiling. So, each car on the road with moderate gas mileage — say, 10 kilometers per liter or 24 miles per gallon — releases enough heat to melt about 4.5 kilograms, or a 10-pound bag, of ice for every kilometer it travels. Much of the energy used in buildings — for lighting, heating and producing hot water, for example — eventually makes its way into the environment as heat.

As a rough guide, Sailor notes, one-third of the anthropogenic heat contribution to an urban heat island comes from transportation, one-third comes from buildings and one-third stems from industrial processes. Nevertheless, all cities are different: The heat island in Houston, for example, is substantially aggravated by the large number of nearby oil refineries.

Although urban heat islands are nothing new, scientists haven't conducted many detailed investigations of the phenomenon, says Brent Hedquist, an urban climatologist at Arizona State University in Tempe. In April 2008, he and his colleagues used portable weather stations and thermal imaging cameras to carry out a round-the-clock study in downtown Phoenix. Some studies, Hedquist says, have shown that the core of that city, one of the fastest growing urban areas in the nation, is on average between 7 and 11 degrees Celsius warmer than the surrounding countryside.

A first look at the Hedquist team's field data qualitatively confirms what many lab studies might suggest: Facades of dense concrete and brick, some of which reached temperatures of 45°C, or 113°F, during the day, retained heat well into

CARLSON *ET AL.*/ARIZONA STATE UNIVERSITY

the night, while glass and metal cooled rather quickly after the sun went down. The details of that warm-up and cool-down, however, will be the topic of intense analyses. "The situation downtown is very complex," Hedquist notes, with daytime heat absorption and nighttime heat loss depending on factors such as the angle at which the sun strikes building facades, the distance between the buildings and the speed and direction of prevailing winds.

By combining the data gleaned downtown with some gathered by helicopter over the city at large, Hedquist and his colleagues intend to construct detailed computer models of the region's landscape and how it responds to heat. Future studies, he says, will enable the team to assess how widespread changes in land cover — adding trees or installing permeable pavements, for example — might affect the size and strength of the region's urban heat island.

A top-down approach

One way to make buildings energy-efficient is to modify their roofs, which are invariably exposed to sunlight. Home-owners may spread a little insulation in the attic, or switch to a lighter-colored shingle when it's time to replace the roof. Large buildings, especially commercial structures, have more options.

So-called green roofs, which coat all or part of a building's upper surface with soil and vegetation, address several urban heat island factors, says Sailor. Not only do green roofs typically absorb less sunlight, but the thick layer of soil also provides some insulation, reducing overall energy use in the building. And, Sailor notes, because the roof is designed to catch precipitation and hold it, potentially polluting runoff is reduced.

Previously, Sailor and his colleagues estimated that converting the impervious roofs of the buildings in Portland's two-square-kilometer industrial district to green roofs would reduce daytime temperatures in the district as much as 0.5 degrees C (*SN: 9/4/04, p. 152*). That would reduce the demand for air conditioning, cutting even further the human contribution to the city's heat island by reducing greenhouse gas emissions.

In the glaring heat of the American Southwest, researchers investigated the energy savings possible from a roof of a different color — a white one. By replacing a moderately reflective roof with one that is superbright, buildings can reduce their energy costs substantially, Joby Carlson, a research scientist at Arizona State University in Tempe, and his colleagues reported at the AMS meeting.

As part of the study, one of Arizona's largest utility providers replaced half of a 20-year-old roof on one of its office buildings in Deer Valley, a Phoenix suburb. Sensors on the roof and at other spots inside the building just under the roof gathered data from mid-August to mid-September 2008. The original portion of the roof was covered with gravel that had an albedo of about 31 percent: In other words, about 69 percent of the sunlight falling on the roof in visible wavelengths was absorbed. The portion of the roof that was replaced was covered with gravel with an albedo of 72 percent, so it absorbed only 28 percent of the sunlight. "It's bright white — you have to put on your sunglasses when you go up there for sure," Carlson says.

The change in albedo made a big difference. On the afternoon of August 20, 2008, when air temperature at the site peaked near 41.7°C, or 107°F, the old portion of the roof heated up to 68°C. Meanwhile, the surface temperature on the roof's newly bright-white portion rose to only 58.9°C. Underneath the roof's cooler portion, temperatures near the ceiling were consistently about 3.3 degrees C lower than temperatures measured under the old roof.

More importantly, says Carlson, the building's energy use during hours of peak demand for electricity decreased. Because utilities must build power plants to meet peak demand, widespread use of white roofs and other energy-saving renovations could forestall or slow the need for additional power plants that would emit more greenhouse gases, he notes. And building fewer power plants is one possible counterpunch in the fight against climate change. ■

Explore more

- Read this story online to learn about more ways to harness waste heat: www.sciencenews.org/urbanheat

RUDY SULGAN/CORBIS

Heat recycling

Two-thirds of the energy locked in the coal and natural gas used to generate electricity at power plants ends up as waste heat, says Thomas R. Casten, chairman of Recycled Energy Development in Westmont, Ill. Casten and Phil Schewe of the American Institute of Physics in College Park, Md., note in the January-February *American Scientist* that unused heat is dumped into the environment. Were power plants closer to customers, Casten suggests, some of that waste heat could be put to work. Consolidated Edison in New York City, for example (smokestacks pictured), delivers heat to thousands of buildings in Manhattan via the world's largest commercial steam system. Even waste heat from industrial processes could generate electricity. — *Sid Perkins*

Made for Each Other: The Biology of the Human-Animal Bond

Meg Daley Olmert

A nursing mother, a pet lover and a horse in a cavalry charge have at least one thing in common: bloodstreams full of oxytocin, Olmert contends in this fascinating book that explores the deep connection between people and animals.

Many studies have linked oxytocin, one of several mammalian hormones produced in the hypothalamus, to maternal bonding, trust and social recognition in several species.

In pregnant humans, a surge of oxytocin stimulates labor. Once a baby is delivered, the neurochemical induces the mother to release breast milk — an elegant symbiotic design that keeps babies fat and happy and can send nursing mothers into a state of dreamy contentedness. At the other extreme, mice genetically incapable of producing oxytocin can't recognize mice that they've previously encountered.

Studies show that stroking pets increases levels of oxytocin in the groomer and the groomed, and the hormone's calming effects may explain the benefits of pet therapy, the connections people forge with individual animals and people's love for animals in general.

Olmert suggests that oxytocin has played a key role in domesticating large mammals and turning them into pets. In horses, for instance, a naturally high level of oxytocin — boosted in the species by evolution and in individuals by a bond with a nurturing horseman — may be key to transforming the gentle creatures into warhorses capable of galloping headlong into the noise and confusion of a battlefield.

This work also explores how urban dwellers become increasingly disconnected from nature and animals. One thought: Rising rates of nervousness and depression could be signs of a population suffering from oxytocin deprivation. — *Sid Perkins*

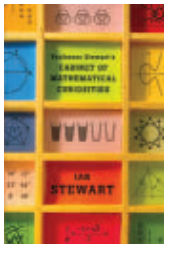
Da Capo Press, 2009, 320 p., $26.

Professor Stewart's Cabinet of Mathematical Curiosities

Ian Stewart

What positive integer is equal to its own Scrabble score when spelled out in full?

Stewart, a mathematician at the University of Warwick in England, offers this and a hodgepodge of other puzzles, paradoxes, brainteasers, tricks, facts and jokes, which he accurately calls "curiosities."



"I incline to the view that a miscellany should be miscellaneous, and this one is," Stewart notes in his introduction.

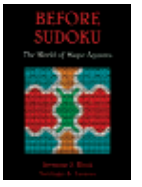
He's not lying. There is no real organization to his assortment, making it ideal for dabbling. Some entries will be skippable; others will inspire you to pull out a pencil and scratch paper.

Stewart revisits the classics: the seven bridges of Königsberg (can you find a path through the city that includes each bridge only once?) and the sausage conjecture (how efficiently can circles or spheres be wrapped?). He also offers originals, describing steps for creating a pop-up dodecahedron, and illuminating the easiest way for Archimedes to have moved the Earth. Some stories are based on geometry, others on logic, probability or plain Jane arithmetic.

For readers who want more information, the book offers additional resources — including, unfortunately, several Wikipedia entries. Unless Stewart plans to check the sites for accuracy regularly, a Google search would likely be just as reliable.

Oh, and the answer to the integer riddle is 12: T, E and L get one point. W and V get four. — *Elizabeth Quill*

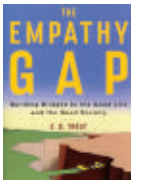
Basic Books, 2009, 310 p., $16.95.



Before Sudoku: The World of Magic Squares

Seymour S. Block and Santiago A. Tavares

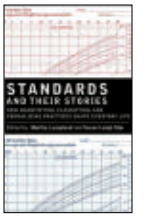
Fascination with sudoku puzzles is not new. *Oxford Univ., 2009, 239 p., $14.95.*



The Empathy Gap: Building Bridges to the Good Life and the Good Society

J.D. Trout

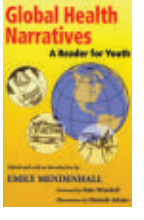
This book argues that empathy and rationality are key to good personal and political decisions. *Viking, 2009, 320 p., $25.95.*



Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life

Martha Lampland and Susan Leigh Star, eds.

Standards are a fact of life, from cradle to coffin size. *Cornell Univ., 2009, 244 p., $22.95.*



Global Health Narratives: A Reader for Youth

Emily Mendenhall, ed.

Short stories for youngsters reveal worldwide public health problems. *Univ. of New Mexico, 2009, 238 p., $21.95.*

Life in Space: Astrobiology for Everyone

Lucas John Mix

How the search for extraterrestrial life helps us understand Earth. *Harvard Univ., 2009, 344 p., $29.95.*

How to Order To order these books or others, visit www.sciencenews.org/bookshelf. A click on a book's title will transfer you to Amazon.com. Sales generated through these links contribute to Society for Science & the Public's programs to build interest in and understanding of science.

Michel Jarraud

For more Comment, visit COLUMNS at **www.sciencenews.org**

Bracing for global climate change is a local challenge

Weather and climate extremes have been affecting people around the world, from recent droughts in China and Australia to strong storms in Asia to a cold wave in large parts of Europe and the United States — all within a month of the World Meteorological Organization reporting 2008 would likely rank among the 10 warmest years on record. The cold wave sparked significant discussion, and the year 2008 ended up slightly colder than the previous year, partially because of the La Niña phenomenon. How could we speak of global warming in the middle of a cold wave in parts of the world? If 2008 was indeed cooler than 2007, is climate change real?

For scientists the answer is clear enough, as the examples mentioned are the result of natural climate variability, which does not contradict the human-induced long-term warming trend. This trend is reported in the Fourth Assessment Report of the United Nations WMO and Environment Programme cosponsored Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize.

Natural variability of the climate system is the cumulative result of four factors: first, the chaotic nature of the climate system; second, the oscillating behavior exhibited by a number of important processes, such as the El Niño–Southern Oscillation; third, variability in solar intensity, mainly determined by shifts in the Earth's orbit and tilt and, to a much lesser degree, by variations in solar activity; and last, the random effect of volcanic eruptions forceful enough to inject sulfur dioxide and particulate material into the high atmosphere.

However, over the past 150 years, human activities have been increasingly changing the climate and producing a net warming. In particular, these activities have altered the natural greenhouse effect through an increase in carbon dioxide and other greenhouse gas levels because of deforestation and by emissions from fossil fuel combustion and land and animal use. The IPCC projects an increase in the occurrence and intensity of a number of weather and climate extremes as a result of climate change. Many of these events have likely changed in scope over the past 50 years, including increased occurrence of heat waves and heavy precipitation. At the same time, climate change is warming the planet, causing ice and snow to melt and sea level to rise.

The challenges posed by climate change affect nearly every sector of society.

The challenges posed by climate variability and change affect nearly every sector of society, including agriculture and fishery, water resources management, health, forestry, transportation, tourism and energy. These sectors are already experiencing increased risks in some regions and, although in some cases new opportunities may arise locally (wine grapes growing farther north, new transportation routes), long-term effects will overall be negative. Adaptation of these sectors will require local-scale climate predictions, tailored to a sector's individual needs. At the same time, on the societal side, better interaction between climate information providers and users will be necessary.

Until now, climatologists had focused essentially on the larger picture and global trends; however, the present situation demands more efforts. To that end, WMO is working on a global framework for developing and providing climate services to meet users' needs. In collaboration with its partners, WMO intends to launch such a framework at this year's World Climate Conference-3 (August 31–September 4 in Geneva).

Scientists from many disciplines and decisions makers from governments, international and nongovernmental organizations, and the private sector will develop an agreement on actions needed to raise current scientific knowledge to the next level — by applying our knowledge to adaptation measures at increasingly local scales.

Take for example the food sector. The 2007 IPCC Fourth Assessment Report outlines the overall projections for Africa: By 2020, the report says, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change, while in some countries yields from rain-fed agriculture could be reduced by up to 50 percent, compromising basic access to food. A key objective is to downscale climate models to advise a farmer in the Sahelian region, for example, when the rainy season will start and how it will compare with previous seasons, for him to adjust and time his crops appropriately. WMO's Regional Climate Forums are already helping to deliver such information to African farmers and others several months in advance.

The next step will be to enhance these services by fully integrating them into the decision-making process, which will require cooperation among all countries and many international partners. It is a necessary and highly cost-effective investment to ensure that we leave a sustainable situation to future generations. ■

Michel Jarraud is secretary-general of the U.N. World Meteorological Organization in Geneva.

WMO

Discover a Mathematical World of Startling Beauty and Insight

Mathematics is one of the most beautiful human endeavors. Its shapes and proportions can inspire artists; its mysteries can tantalize theoreticians; and its demands for insightful habits of thinking can help you develop skills useful to your daily life. Now the highly effective strategies of thinking from this remarkable mathematical world are available to you in **The Joy of Thinking: The Beauty and Power of Classical Mathematical Ideas**.

These 24 clear and entertaining lectures require no specialized knowledge and are appropriate for both high-school students and adults. Award-winning Professors Michael Starbird and Edward B. Burger—authors of the acclaimed math book, *The Heart of Mathematics: an invitation to effective thinking*—show you how to make sense of the world through numbers, geometry, and probability. They'll leave you with a firm grasp of the field's most fundamental ideas and a new appreciation for the math that surrounds you.

This course is one of The Great Courses®, a noncredit recorded college lecture series from The Teaching Company®. Award-winning professors of a wide array of subjects in the sciences and the liberal arts have made more than 250 college-level courses that are available now on our website.

The Joy of Thinking: The Beauty and Power of Classical Mathematical Ideas

Taught by Professor Edward B. Burger, Williams College
Professor Michael Starbird, The University of Texas at Austin

Lecture Titles

1. Great Ideas that Bring Our World into Focus
2. How Many? Counting Surprises
3. Fermat's Last Theorem and the Allure of Number
4. Pining for Nature's Numbers
5. Sizing up the Fibonacci Numbers
6. The Sexiest Rectangle
7. The Hidden Beauty of the Golden Rectangle
8. The Pythagorean Theorem and Geometry of Ellipses
9. Not-so-Platonic Relationships in the Platonic Solids
10. Hunting for a Sixth Platonic Solid
11. Is There a Fourth Dimension? Can We See It?
12. The Invisible Art of the Fourth Dimension
13. A Twisted Idea—The Möbius Band
14. A One-Sided, Sealed Surface—The Klein Bottle
15. Ordinary Origami—Creating Beautiful Patterns
16. Unfolding Paper to Reveal a Fiery Fractal
17. Fractals—Infinitely Complex Creations
18. Fractal Frauds of Nature
19. Chance Surprises—Measuring Uncertainty
20. Door Number Two or Door Number Three?
21. Great Expectations—Weighing the Uncertain Future
22. Random Thoughts—Randomness in Our World
23. How Surprising are Surprising Coincidences?
24. Life Lessons Learned from Mathematical Thinking

Order Today!
Offer expires Wednesday, June 10, 2009

The Joy of Thinking: The Beauty and Power of Classical Mathematical Ideas
Course No. 1423
24 lectures (30 minutes/lecture)

DVDs ~~$254.95~~ NOW $69.95
+ $10 Shipping, Processing, and Lifetime Satisfaction Guarantee

Priority Code: 33311

ACT NOW!

1-800-TEACH-12
www.TEACH12.com/7sn

The Teaching Company®
The Joy of Lifelong Learning Every Day™
Great Professors, Great Courses, Great Value Guaranteed.™

The simplest, most accurate watch on the planet!

You never have to set this watch…
in fact you never even have to look at it.

This new Talking Atomic Watch is the ultimate in simplicity, accuracy, and practicality. It's accurate to within a billionth of a second… and it talks!

I just threw my watch in the trash. I got it as a gift a while back—and it was something else. It had four different digital displays, about a dozen buttons, was waterproof to about a thousand feet, and I think it could even tell me the weather. I'll never know, though, because, like I said, it's in the trash. Turns out it couldn't do the one thing I want a watch to do … tell me the correct time. It always ran a little slow, which was bad enough, but there were so many displays and they were so small that I couldn't tell the time even if it was accurate. When I tried to reset it I pushed the wrong button and set it on military time, and I couldn't figure out how to switch it back. That was the last straw. Now, I've got a great watch. It's super-accurate, easy-to-read, and it will even tell … yes tell … me the time. Best of all, I'll never have to set it! This is the watch I've been waiting for.

Whether you travel or not… this watch is a necessity.

This Talking Atomic Watch from *first*STREET maintains its phenomenal accuracy because it is designed to receive a signal from the US Atomic Clock in Fort Collins, Colorado. This clock is the standard for time measurement worldwide… it can go 20 million years without gaining or losing a second! It never needs to be set, because it automatically adjusts itself for daylight savings time and leap years.

Easy to read, Even easier to hear.

The most accurate watch in the world is of no use if you can't read it. This timepiece is designed to tell you the correct time… anytime. It features a clear, uncluttered analog display that you won't need reading glasses to see. Best of all, you can press a button and it will tell you the time in a clear, easy-to-understand voice. So whether you're driving to an appointment or dining in a candle-lit restaurant … you are sure to know the exact time. Press another button and it will even tell you the day and date if you want. There's even an automatic hourly chime.

Try it for yourself… it's risk-free.

The US Atomic Clock cost billions to build and maintain, but you can have the next best thing for less than one hundred dollars. Thanks to a special arrangement with the manufacturer, we can offer you this watch at a special price with our exclusive home trial. Call now, and we'll give you a $10 INSTANT DISCOUNT and FREE SHIPPING. If you are not completely amazed by the accuracy and quality of this product, simply return it within 90 days for a full "No Questions Asked" refund.

Talking Atomic Watch ~~$99.95~~ **$89.95***

After $10 Instant Rebate* **Call now for free shipping.

1-877-499-6575

Please mention code ***37993*** when ordering.

www.atomictimedirect.com

Senior Approved Services

*first*STREET® for Boomers and Beyond®

1998 Ruffin Mill Road • Colonial Heights, VA 23834

50062