Ultracosmic Collisions How Feathers Flash Child Warriors Survive

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC = JUNE 7, 2008

(why insects are good for you, and the planet)

Extinct DNA Revived Measuring Molecular Morphing A Tangled Web of Proteins



# SOCIETY FOR SCIENCE & THE PUBLIC

Inform. Educate. Inspire.



# Inform. Educate. Inspire.

Science has the power to awaken the intellect, challenge the status quo, and inspire the imagination. A scientific framework helps us to approach, understand, and address life's most challenging questions.

Society for Science & the Public (SSP) is a nonprofit organization dedicated to the public engagement in scientific research and education. Founded in 1921 as Science Service, SSP conveys the excitement of science and research to all we reach through our award-winning magazine, Science News, and world-class science education competitions, including the preeminent Intel Science Talent Search.

Our vision is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire.

www.societyforscience.org



# **ScienceNews**

# In the News

#### STORY ONE 5

Children pressed into service as soldiers can show remarkable resilience despite their traumatic experiences

#### 7 MOLECULES

New method captures molecules as they morph from one form to another

#### 8 EARTH

Antarctic ice core tells tales of carbon dioxide and temperatures from long ago

#### 9 LIFE

DNA from an extinct Australian marsupial is resurrected to function in a living mouse

# **10 GENES & CELLS**

Tangled web of protein interactions hints at roots of human complexity

# 11 BODY & BRAIN

Technique may help identify embryos most likely to succeed with in vitro fertilization

With help from areas adapted for hearing, brains can remember how to see

Heavy marijuana use may increase the risk of heart disease

# 12 ATOM & COSMOS

Proposed tests could tell whether humans occupy a special place in the universe

Shifting of Europa's icy shell ups the odds in favor of subsurface life

# **13 SCIENCE & SOCIETY**

Scientists of the future go for the gold at the Intel International Science & Engineering Fair

# Features

# 16 INSECTS (THE ORIGINAL WHITE MEAT)

In many parts of the world, diners desire insects, and scientists are exploring the nutritional value of bug eating and its environmental impact.

By Janet Raloff

# 22 WHEN WORLDS COLLIDE

Many cosmologists believe that our universe is one of countless spacetime bubbles populating a vast cosmic void. And if another bubble hit ours, the skies might show a sign of the collision. Bv Diana Steele

# 26 HOW THEY SHINE

Scientists are investigating whether the iridescence of peacock feathers and butterfly wings is pretty meaningful or just pretty colorful. By Susan Milius

# Departments

- 2 FROM THE EDITOR
- SCIENCE NOTEBOOK 4
- 30 FEEDBACK
- 31 SN BOOKSHELF
- 32 COMMENT

Harvard provost Steven Hyman reflects on support for science in Singapore and China compared with the United States.



On the cover: A plate of water beetles marinated in ginger-and-soy sauce, a meal served in China, sits atop swimming water beetles. Photo: Peter Menzel

# Science News

#### 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

Associate Editor Elizabeth Quill Astronomy Ron Cowen Behavioral Sciences Bruce Bower Biomedicine Nathan Seppa Biotechnology Patrick Barry Earth Sciences Sid Perkins Life Sciences Susan Milius Molecular Biology Tina Hesman Saey Physical Sciences Davide Castelvecchi Staff Writer Rachel Ehrenberg

Editorial Assistant Amy Maxmen Web Specialist/Editorial Secretary Gwendolyn K. Gillespie Web Intern Tia Ghose

#### Design

Design Director Bob Gray

#### Advertising/Circulation

Associate Publisher Jonathan Oleisky Advertising Manager Judy Lewis Account Executives Regan Pickett, John Pellettieri, Robert Sparkman Circulation Manager Tosh Arimura Advertising/Circulation Assistant Matt Greene

#### Editorial, Advertising & Business Offices

1719 N Street NW, Washington, DC 20036 Phone (202) 785-2255

scinews@sciencenews.org Letters: editors@sciencenews.org

Science News (ISSN 0036-8423) is published biweekly, for \$54.50 for 1 year or \$98.00 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: P.O. Box 1205, Williamsport, PA 17703-1205. For new subscriptions and customer service, call 1-800-552-4412.

Postmaster: Send address changes to Science News, P.O. Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided. Copyright © 2008 by Society for Science & the Public. Title registered as trademark U.S. and Canadian Patent Offices. Printed in U.S.A. on recycled paper.

#### Society for Science & the Public

#### **Board of Trustees**

Chairman Dudley Herschbach, Vice Chairman Robert W. Fri, Secretary David A. Goslin, Treasurer Frederick M. Bernthal. Members Jeanette Grasselli Brown, S. James Gates Jr., Samuel Gubins, J. David Hann, H. Robert Horvitz, Walter Isaacson, Shirley M. Malcom, Eve L. Menger, Anna C. Roosevelt, Vera Rubin, Jennifer E. Yruegas, Elizabeth Marincola, ex officio.

#### Executive Office

President Elizabeth Marincola Executive Assistant Madeline Azoulay

#### Finance

Chief Financial Officer Greg Mitchell Accounting Manager Lisa M. Proctor Development and

#### **Corporate Relations**

Director of Development and Corporate Relations Rick Bates Public Relations and Donor Relations Tzeitel Hirni

#### **Events Management**

Director of Events Cait Goldberg Events Associate Michaela Curran

#### Science Education Programs

Director Michele Glidden Program Manager, Intel Science Talent Search Katherine I. Silkin Office Manager June Kee Program Associates Diane Rashid, Jinny Kim, Laurie Demsey, Tsharre Tention

#### **Internal Operations**

Director Harry Rothmann Facilities Manager Paul Roger Logistics Manager Anthony Payne Mail Room Clerks Ben Bryan, Kerwin Wilson

Receptionist Evora Swoopes Computer Programmer/Webmaster Thomas D. Smith

Systems and Network Administrator James C. Moore

IT Specialists Gregory A. Sprouse, Jiayin Chen

Society for Science & the Public is a 501(c)3 nonprofit corporation founded in 1921. The vision of Society for Science & the Public is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire. Visit Society for Science & the Public at www.societyforscience.org.

Republication of any portion of Science News without written permission of the publisher is prohibited. For permission to photocopy articles, contact Copyright Clearance Center at 978-750-8400 (phone) or 978-750-4470 (fax).

# Pigeonholing stories on birds, bubbles, bugs



One of the enduring strengths of *Science News* is its scope. Its pages are open to all fields of science and their subspecialties, to all the realms of human inquiry into the natural (and artificial) world, whether physical, biological or social.

Of course, carving all that up into

meaningful categories for labeling magazine pages isn't simple. The old 19th century disciplinary divisions don't really work so well in the current interdisciplinary era. So our pages use a flexible system of general purpose topic names to organize the news by areas of interest.

Biology fans, for instance, will want to watch for pages labeled Life and perhaps Environment. For chemistry, keep an eye out for Molecules. Hard-core devotees of condensed matter physics will gravitate toward Matter & Energy. If you're into gravity, cosmology, astronomy and particle physics, watch for Atom & Cosmos. Social sciences of all sorts, along with archaeology and anthropology, show up under Humans. And the frontiers of medicine, neuroscience and molecular genetics appear under Body & Brain or Cells & Genes. And don't forget all the new science that has to do with the Earth, cleverly disguised by the label Earth.

For those of you who prefer more traditional categories, the *Science News* website, www.sciencenews.org, can still be searched for topics like botany and zoology, psychology and paleontology. News from such traditional fields can be found in the subtopic available by clicking on a main topic label at the top of the home page. Physics stories, for example, can be accessed under both Atom & Cosmos and Matter & Energy. You'll find botany, zoology and ecology under Life.

Even with such a flexible system, some stories defy easy listing. This issue's features provide some excellent examples. From the frontiers of human eating habits, we present Janet Raloff's report on entomophagy, which merges entomology, nutrition and food science into a tasty intellectual feast. From beyond the frontiers of the universe, we offer freelancer Diana Steele's account of "bubble universes" that may smash into the one that humans call home — blurring the boundary between cosmology and science fiction. And from cosmic distances we revert to the nanoscale, where light and matter interact to generate the beauty of iridescence in birds and other beasts, mixing physics and geometry with biology.

Naturally, the fun of combining so many sciences in each feature outweighs the trouble posed in deciding on a category. Besides, we don't put category labels on features. —Tom Siegfried, Editor in Chief

# What Did They Do Before Zero?

# Discover the Answers to the Great Mathematical Questions

The 4,000-year history of mathematics is filled with astonishing scientific discoveries, quests for solutions to proofs and practical problems, and a remarkable range of brilliant minds. Now you can explore the fascinating evolution of our understanding of the mathematical world with **The Queen of the Sciences: A History of Mathematics**.

Over the course of 24 illuminating halfhour lectures, award-winning Professor David M. Bressoud guides you through the amazing progression of this field from ancient Mesopotamia to the Human Genome Project. You journey across continents, cultures, and time periods, encounter specific mathematical problems and larger theoretical issues, and meet the great mathematicians who discovered and challenged them.

Some of the historical periods you explore in depth throughout the course include:

- The early Islamic world, where mathematical achievements such as the first treatise on solving an algebraic equation played an important role in the development of European mathematics
- 17<sup>th</sup>-century Europe, where the existing ideas of geometry, algebra, and trigonometry were refined and forged into the new tool of calculus
- The last 200 years, which saw developments like Bernhard Riemann's new system of geometry that provided a framework for Einstein's revolutionary conception of space in his general theory of relativity

Mathematics (called "the queen of the sciences" by the German mathematician Carl Friedrich Gauss) has helped us uncover the nature of our physical reality—an observation even more accurate today, when mathematics-intensive disciplines like string theory, chaos theory, and information technology are transforming the way we understand and deal with the world.

By following the story of this powerful field of study, you will better appreciate the enormous efforts that went into deciphering the secrets of our natural world.

No mathematical expertise is required to embark on this fascinating adventure—only an inquiring mind.

#### **About Our Sale Price Policy**

Why is the sale price for this course so much lower than its standard price? Every course we make goes on sale at least once a year. Producing large quantities of only the sale courses keeps costs down and allows us to pass the savings on to you. This approach also enables us to fill your order immediately: 99% of all orders placed by 2 pm eastern time ship that same day. Order before August 6, 2008, to receive these savings.



The abacus is a calculating tool used by many cultures.

#### **About Your Professor**

David M. Bressoud is the DeWitt Wallace Professor of Mathematics in the Department of Mathematics and Computer Science at Macalester College, where he has also served as Chair of the department. He earned his Master's and Ph.D. in Mathematics from Temple University.

A former Fulbright Fellow and Sloan Foundation Fellow, Professor Bressoud has served as Visiting Professor at the Institute for Advanced Study and the Mathematical Association of America's Pólya Lecturer, and has received the Mathematical Association of America's Allegheny Mountain Section Distinguished Teaching Award.

#### About The Teaching Company<sup>®</sup>

We review hundreds of top-rated professors from America's best colleges and universities each year. From this extraordinary group we choose only those rated highest by panels of our customers. Fewer than 10% of these world-class scholar-teachers are selected to make The Great Courses. We've been doing this since 1990, producing more than 3,000 hours of material in modern and ancient history, philosophy, literature, fine arts, the sciences, and mathematics for intelligent, engaged, adult lifelong learners. If a course is ever less than completely satisfying, you may exchange it for another, or we will refund your money promptly.

#### Lecture Titles

- 1. What Is Mathematics?
- 2. Babylonian and Egyptian Mathematics
- 3. Greek Mathematics—Thales to Euclid
- 4. Greek Mathematics—Archimedes to Hypatia
- 5. Astronomy and the Origins of Trigonometry
- 6. Indian Mathematics—Trigonometry Blossoms
- 7. Chinese Mathematics—Advances in Computation
- 8. Islamic Mathematics—The Creation of Algebra
- 9. Italian Algebraists Solve the Cubic
- 10. Napier and the Natural Logarithm
- 11. Galileo and the Mathematics of Motion
- 12. Fermat, Descartes, and Analytic Geometry
- 13. Newton—Modeling the Universe
- 14. Leibniz and the Emergence of Calculus
- 15. Euler—Calculus Proves Its Promise
- 16. Geometry—From Alhambra to Escher
- 17. Gauss—Invention of Differential Geometry
- 18. Algebra Becomes the Science of Symmetry
- Modern Analysis—Fourier to Carleson
   Riemann Sets New Directions for Analysis
- 21. Sylvester and Ramanujan—
- Different Worlds
- 22. Fermat's Last Theorem— The Final Triumph
- 23. Mathematics—The Ultimate Physical Reality
- 24. Problems and Prospects for the 21st Century

THE TEACHING COMPANY<sup>\*</sup> The Joy of Lifelong Learning Every Day<sup>\*</sup> GREAT PROFESSORS, GREAT COURSES, GREAT VALUE GURANTEED.<sup>\*</sup>

SAVE \$185! Offer good until August 6, 2008	
1-800-TEACH-12 (1-800-832-2412) Fax: 703-378-3819	Special offer is available online at www.TEACH12.com/3sn
Great Courses THE TEACHING COMPANY 4151 Lafayette Center Drive, Suite 100 Chantilly, VA 20151-1232	Charge my credit card:           Image: Imag
Priority Code 28086 Please send me The Queen of the Sciences:	Signature
A History of Mathematics, which consists of twenty-four 30-minute lectures plus Course Guidebooks.	Name (please print) Mailing Address
DVD \$69.95 (std. price \$254.95) SAVE \$185! plus \$10 shipping, processing, and lifetime satisfaction guarantee.	City/State/ZIP
Check or Money Order Enclosed	PHONE (If we have questions regarding your order—required for international orders)
<ul> <li>Non-U.S. Orders: Additional shipping charges apply. For more details, call us or visit the FAQ page on our website.</li> <li>** Virginia residents please add 5% sales tax.</li> </ul>	<ul> <li>FREE CATALOG. Please send me a free copy of your current catalog (no purchase necessary).</li> <li>Special offer is available online at www.TEACH12.com/3sn</li> <li>Offer Good Through: August 6, 2008</li> </ul>



# Scientific Observations

"I think music is part of communication. I think it is part of the way that people touch each other, and that is very precious to me. And astronomy is in a sense an opposite thing because instead of looking inwards and looking towards the people around you, you are looking out, out, out to what is outside ourselves and beyond our grasp. I think in a way the inner space and outer space are complementary."

**RECEIVING HIS ASTROPHYSICS PH.D. HE IS COAUTHOR OF BANG:** A COMPLETE HISTORY OF THE UNIVERSE.

# Science Past: 50 Years Ago From Science News Letter. June 7, 1958

CARBON DIOXIDE CHANGES UNDIFFERENTIATED CELLS - When carbon dioxide is bubbled into a solution containing undifferentiated cells that have just begun to grow after egg fertilization, the cells become brain cells. Dr. Reed Flickinger, zoologist at the University of California at Los Angeles, is studying the process by which like embryonic cells suddenly begin to specialize to form specific structures such as brain, muscle, skeleton, and reproductive organs. Addition of small amounts of carbon dioxide - large amounts kill the cells - to undifferentiated frog embryo cells caused the cells to form nervous tissue the day after fertilization, Dr. Flickinger said. Three to four days later definite brain structures could be identified. Apparently the carbon dioxide stimulates protein synthesis in the cell by causing release of nucleic acids and storage protein from the yolk granules packed in the cell, the UCLA zoologist said. All cells have equal potential of becoming brain cells.... But some unknown stimulus makes them specialize.

# **Science Future**

# June 15

Baseball as America opens at the Boston Museum of Science. Visit www.mos. org/exhibits\_shows/coming\_ soon&d=2472

# June 29–July 3

The Ninth International Conference on Permafrost at the University of Alaska Fairbanks. Visit www.nicop.org/

# July 27/28

Southern  $\delta$ -Aquariids meteor shower peak. Visit www.imo. net/calendar/2008

# **SN Online**

www.sciencenews.org

# MATHTREK

Find out what data structure is hidden within photographs, why topologists like to say there is no difference between a coffee cup and a doughnut and what exactly the squint method of analysis is all about in recent columns by Julie J. Rehmeyer.

## **SCIENCE & THE PUBLIC**

Everyone knows about the Kyoto Protocol, but the nearly forgotten Montreal Protocol may have had a bigger impact on climate. Learn how this 20-year-old treaty slowed runaway global warming in Janet Raloff's May 18 post in Blogs.

## SIGHTS & SOUNDS

Physical sciences writer Davide Castelvecchi describes



how a digital X-ray holds clues to a 2,500year-old mummy's demise.

# NEWS

Read news stories and watch the accompanying video of magnetic fields that churn solar jets, or a chimp inventor discovering and improving on a new tool to catch ants. Learn what's happening in science today with breaking news stories published online every weekday.

#### **STAY CONNECTED**

The Science News website offers targeted e-mail alerts and RSS feeds that send the latest news headlines out to readers.

# **How Bizarre**

Bubbles bursting in lava lakes make characteristic sounds. By listening, scientists think they can better understand geophysical processes. But lava is hard to come by in the lab. Instead, researchers have turned to hair gel. With a little water, the drugstore product mimics lava's mechanical properties. Curry and tomato sauces will do but prove less stylish. The work appears in an upcoming Physical Review Letters.

# Science Stats

# IN THE KNOW

Primary source of information about science and technology for adults in the United States



SOURCE: UNIVERSITY OF CHICAGO NATIONAL OPINION RESEARCH CENTER

**4** This is the next logical step to try to bring ancient DNA into an animal or biological system. **77** — **STEPHAN SCHUSTER, PAGE 9** 

Molecules Slowpokes surprise chemists

Earth Icy clues to past climate

Life Resurrecting extinct DNA

Genes & Cells All about the interactions

Body & Brain Identifying ideal embryos

Atom & Cosmos A privileged place

Science & Society Up-and-comers compete

# **Inthe News**

STORY ONE

# Lost are found

Child soldiers can reenter, thrive in former community

#### By Bruce Bower

shmael Beah knows that former child soldiers in war-ravaged African countries can reclaim their lives, because that's just what he did. In 1993, when Beah was 13, rebels in Sierra Leone killed his parents and two brothers, forcing him to join a bloody campaign for two years. Upon his release, he stayed at a rehabilitation center for six months with other formerly abducted children. Beah now lives in the United States, and in 2007 he published a book about his transition from child soldier to college graduate.

His inspiring story illustrates the resilience of children forced into committing unthinkable acts, especially if those children receive both treatment that blends with their cultures and acceptance back into their home communities.

A UNICEF report places the current number of soldiers under age 18 at about 300,000 from more than 30 countries. Such figures rely mainly on guesswork, Columbia University education scholar Neil Boothby says. "There are no reliable data on the number of child soldiers."

New studies challenge the popular view that children forced to commit war atrocities end up as "lost boys," incapable of ever leading constructive lives. "Declaring child soldiers to be 'lost boys' is simply unacceptable," Beah says.

Beah joined researchers who study former child soldiers May 5 in Washing-



ton, D.C., at the annual meeting of the American Psychiatric Association.

"Emotional resilience is the norm," says psychologist Jeannie Annan of New York University, who studied former child soldiers in Uganda. "Family rejection and emotional distress are the exception."

Consider 40 boys abducted into a rebel army in the East African nation of Mozambique more than 20 years ago. By 2004, 37 of them had returned to their home communities and displayed good social and psychological functioning as adults, according to Boothby.

"These are wonderful young men," Boothby says. "They had done bad things in their home villages as child soldiers, but the villagers wanted them back."

Psychiatrist Jon Shaw of the University of Miami in Florida first contacted the boys in 1988. Government forces had freed the youngsters from the rebel group and the government endorsed an effort to rehabilitate them and return them to their families. Shaw converted a Catholic school into a rehabilitation center that offered group activities, including sports, art and music. Boys stayed there for six months before going home to rural villages, where they participated in cleansing rituals that allowed villagers to forgive the boys.

Children abducted to serve as child soldiers serve many roles, Shaw notes, such as porters, cooks, human shields, spotters, spies, minefield sweepers and participants in suicide missions. About one-third of child soldiers are girls, whom rebel leaders also use as sex slaves.

Boothby's team examined the young men's abilities to assist neighbors in times of need, a sign of maturity in Mozambique. He also evaluated their psychological adjustment.

All the boys had recurrent thoughts or memories of traumatic wartime events, even as adults. Over the course of the » For today's top science news, visit SN Today at **www.sciencenews.org** 

» study, the number who avoided places or activities that reminded them of past atrocities increased from 15 to 26. Despite their disturbing memories, 37 boys grew up to own their own homes. Most married and had children.

In 2004, a majority of the former child soldiers cited examples of having helped neighbors in the past year. Interviews with those neighbors confirmed the reports.

Three former child soldiers did poorly after returning to their villages. One repeatedly got into trouble and died in a police shooting. Another was ostracized for alcoholism. A third struggled with emotional problems and an inability to relate to others. He had been abducted by rebels at age 6 after seeing his parents brutally murdered and his house burned down. "This was the worst case of trauma that I've ever seen," Shaw says.

Boothby plans to track the young men for at least another 10 years.

Ugandan communities have also welcomed back former child soldiers. From 2005 to 2007, NYU's Annan and her colleagues interviewed a random sample of 1,000 families in parts of Uganda that had been exposed to 20 years of conflict between government forces and a rebel group called the Lord's Resistance Army. About half of a group of 741 males, ages 14 to 30, and 619 females, ages 14 to 35, reported having been abducted by the LRA.

Participants often described trauma and depression symptoms that lasted for years after their release. Yet they had largely reintegrated themselves into civilian life. Almost all the boys and 80 percent



This child's view of war is reprinted from *Where is My Home?*, a compilation of drawings by children at centers for former child soldiers. It was published in Kampala, Uganda, by several organizations.

of the girls were accepted by their families without problem after leaving the LRA.

Family difficulties emerged for a minority who had spent many years as soldiers, blamed themselves for what had happened and felt haunted by spirits of those they had harmed or killed.

Psychological treatment for former child soldiers in Uganda shows promise as a way to ease lingering depression, says Judith Bass of Johns Hopkins University in Baltimore. In a 2007 study, her team adapted a form of group therapy for use in Uganda. Trained, local counselors delivered this therapy to 105 teenagers in two camps for displaced persons. The youngsters had been abducted by rebels, had witnessed murders or had experienced other war-related traumas. Constant worrying, social withdrawal and other signs of depression substantially declined after four months of weekly therapy sessions.

Definitive treatment and outcome studies of former child soldiers have yet to be conducted, cautions psychiatrist Myron Belfer of Harvard Medical School in Boston. As Ishmael Beah emphasizes, recovery takes many years. "I couldn't sleep much as a child soldier, and I still don't sleep more than three or four hours a night," he says. ■



# Molecules

For more Molecules stories, visit **www.sciencenews.org** 

# With a closer look, chemists find molecules switch shapes slowly

Findings may challenge theory explaining vibrations

## By Davide Castelvecchi

Chemists can now watch the structures of molecules as they change shape, much like shooting multiple frames of a galloping horse. The new view reveals that when certain molecules switch between different conformations, they do so less often than expected — a finding that could require chemists to revise their theories and that could lead to a better understanding of processes such as how proteins fold.

Brooks Pate of the University of Virginia in Charlottesville brought the time-honored chemistry tool called rotational spectroscopy into the digital era. His team can now collect data about molecules 100 to 10,000 times faster than was previously possible, essentially combining multiple frames in one shot. "It used to be that it would take three to four months" to take a similar amount of data, Pate says. "Now you can do it in one day."

"It's a very sleek little design," comments John Pearson of NASA's Jet Propulsion Laboratory in Pasadena, Calif.

Using the new technique, Pate's team looked at a small organic molecule in which a carbon atom sticks out like an arm, attached to another carbon atom. Vibrations of the molecule can make the arm randomly switch between two different stable positions. The researchers found that the molecules wiggle their carbon arms about 10 billion times a second — one-sixteenth as fast as the chemists had predicted based on prevailing theory. The team's results appear in the May 16 *Science*.

The team repeated the experiment with about 10 other types of relatively small molecules, Pate says. All results disagreed with the prevailing theory of how vibrations move across a molecule and lead it to change shape or break up into pieces.

Terry Miller of Ohio State University in Columbus says that the calculation methods commonly used to get such the-

oretical predictions may need some amendment, although the basic tenets of the theory may in the end survive unscathed. Miller authored an accompanying commentary on the work in the same issue of *Science*.

"There's clearly more going on with these molecules than we understand," adds Pearson. A more precise theory would shed light on complex phenomena that involve molecules changing shape. For example, as a protein folds, it changes shape as bonded atoms pivot around one another.

The new method could also shed light on phenomena that involve molecules both changing shape and reacting chemically — such as, Pearson says, the firing of gunpowder.

The approach makes possible quick, accurate chemical analyses, such as of harmful chemicals

used in a non-conventional attack, Pate says. The closer view of molecules could also help astrophysicists discover new molecules in the interstellar medium by matching these molecule's radio-emission signatures with those seen in the lab.

The experiments were made possible

by recent advances in digital electronics, Pate says. "You just could not imagine doing this 10 years ago."

In rotational spectroscopy, a beam of molecules is exposed to microwave radiation. If the molecules are "polar" — meaning they have an uneven distribution of electrical charge — the microwaves' electric fields will apply a torque to them, making them rotate slower or faster. As the molecules' spinning rates change,



Chemists can now watch as molecules such as cyclopropane carboxaldehyde (shown here) switch back and forth between two configurations. the molecules give off radiation at frequencies characteristic of the molecules' structure. In particular, a molecule that has an arm sticking out will tend to rotate at a slower pace (and to send out lower-frequency radiation) than one with a "retracted" arm. "It's the ice-skater phenomenon," Pate says.

In the past, researchers had to look at the molecules' radiation one frequency at a time, essentially by turning a radio dial. "It was like tuning your receiver," Pate says. Instead, Pate's team used a digital device that picks up all frequencies from all molecules at once.

The team then looked at molecules as they change shape — a process during which the molecules go through many intermediate steps, emitting radiation at a particular frequency for each step.

A further refinement, Pate says, could enable researchers to track other types of chemical reactions as they happen, such as a molecule breaking up. For example, scientists could zap a molecule with a laser and time how quickly a bond's length changes before it breaks. ■

# Earth



For more Earth stories, visit **www.sciencenews.org** 

# Antarctic ice tells tale of time with low carbon dioxide levels

Core reveals temperature shifts over 800,000 years

# By Sid Perkins

A kilometers-long ice core from Antarctica has recorded climate information for the past 800,000 years and has revealed three millennia during which carbon dioxide levels in the air were lower than any previously measured.

The longest detailed records of atmospheric gases previously reported, from the uppermost sections of a 3.2-kilometer-long ice core drilled in eastern Antarctica, go back 650,000 years, says Thomas Stocker, a climate physicist at the University of Bern in Switzerland. Isotopic analyses of the ice in the deepest portions of that sample - between 3,060 meters and 3,190 meters - have revealed how the temperature in the region varied between 650,000 and 800,000 years ago. But researchers previously hadn't assayed the gases trapped in bubbles in that portion of the core, Stocker notes. He and his colleagues have now performed those analyses and reported their findings in the May 15 Nature.

Once snow piles up 80 meters or so, the pressure at the bottom of the heap converts densely packed, somewhat porous snow into impermeable ice, thereby locking bubbles of air in place. As snow continues to accumulate, the mass of ice — whether a mountain glacier or a continent-wide ice sheet — becomes a chronicle of long-term variations in the atmospheric concentrations of various gases, including those such as carbon dioxide and methane that are linked to climate change.

In many aspects, the new results provide no surprises, Stocker says. Earth did indeed plunge into an ice age about every 100,000 years, punctuated by warm spells, or interglacials, that lasted about 10,000 years. And, as found in previous studies of this core's shallower ice, the rises and falls of the region's temperature are closely linked to increases and decreases in levels of carbon dioxide and methane trapped in the ice's bubbles. In other aspects, however, the samples provide new clues about ancient climate.

Previously, ice core studies have found that natural levels of atmospheric carbon dioxide varied between 180 and 300 parts per million. However, during a 3,000-year period that began about 670,000 years ago,  $CO_2$  levels dropped to a minimum of 172 ppm, a low level unseen in other, more recent samples. Since the Industrial Revolution began,  $CO_2$  concentrations have been on the rise because of the burning of fossil fuels; today, levels of that greenhouse gas exceed 380 ppm and are increasing, on average, about 2 ppm each year (*SN: 5/10/08, p. 18*).

The geologic record, including seafloor sediments, suggests that the long-term average amount of  $CO_2$  in the air has been declining for at least 50 million years. The new findings, however, hint that atmospheric levels of  $CO_2$  in general rose between 800,000 and 400,000 years ago and then began to decline again.

Also, the researchers report, interglacial periods between 800,000 and 400,000 years ago weren't as warm as those that have occurred more recently. These variations, although small, may reveal previously unrecognized cycles in climate that scientists don't yet understand, Stocker says.

Determining the duration and magnitude of these cycles, if indeed they are real, may require that scientists discover Antarctic locales that harbor ice older than 800,000 years, says Ed Brook, a paleoclimatologist at Oregon State University in Corvallis. The coldest and thickest parts of the ice sheet in East Antarctica, for example, may retain deep ice that fell as precipitation more than 1.5 million years



Researchers drilled a 3.2-kilometer ice core in Antarctica (portion above). Concentrations of carbon dioxide and methane in bubbles of ancient air (dark spots below) trapped in the ice provide clues to past climate.



ago, he notes. Samples that old, he adds, could help solve a long-standing mystery posed by the geologic record: Why does a 100,000-year–long climate cycle recorded in recently deposited ocean sediments disappear in rocks laid down as sediments more than 900,000 years ago?

Even if scientists never find ice more than 800,000 years old, the new findings confirm that Earth's atmosphere today is unusual, Brook says. "Modern levels of greenhouse gases have no natural analogue in the ice record," he notes.

# Life

# A step back from extinction

# Tasmanian tiger DNA turns on gene in mouse

# By Tina Hesman Saey

Tasmanian tigers are back. Sort of. A small bit of the extinct marsupial's DNA is alive and well in the cells of some genetically engineered mice.

Researchers have produced proteins from mammoth and Neandertal genes in cells. But the new study, published May 19 in *PLoS ONE*, is the first to show activity of an extinct piece of DNA in an animal.

Scientists from the University of Melbourne in Australia and the University of Texas M.D. Anderson Cancer Center in Houston extracted DNA from alcoholpreserved specimens of the Tasmanian tiger, or thylacine, extinct since 1936. The researchers then inserted into mice a piece of thylacine DNA that controls production of a collagen gene. The thylacine DNA worked, switching on a marker gene in cartilage-producing cells in a mouse embryo, essentially resurrecting a bit of the extinct animal.

But don't expect mice to transform into the doglike marsupials, or to see thylacines reanimated through cloning.

"This technology can tell us interesting things about thylacines bit by bit," says Robin Lovell-Badge, a developmental geneticist at the Medical Research Council's National Institute for Medical Research in Mill Hill, England. "As far as bringing back thylacines, this is not going to be able to do that."

But the researchers never intended to bring back the thylacine, just to learn something more about its biology and evolutionary history.

"We were very interested in finding out a little bit more about this iconic Australian carnivore, especially since we humans were responsible for its extinction," says biologist Marilyn Renfree of



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

the University of Melbourne, one of the study's authors.

To prove that DNA from an extinct species can still work, the team chose a regulatory element, called an enhancer, which regulates the *COL2A1* gene, says Andrew Pask, a molecular biologist at the University of Melbourne.

Enhancers serve as landing pads for proteins that turn genes on. Only specific proteins are granted landing privileges and only at prescribed times of development in particular cell types. The *COL2A1* enhancer turns the gene on only in chondrocytes – cartilage-producing cells – in mouse embryos. The mouse embryos engineered with the thylacine enhancer turned on production of a marker that the researchers use to track gene activity. The enhancer worked only

in chondrocytes.

The study is the first to use DNA from an extinct species to regulate gene activity. Previous studies used ancient DNA to encode proteins in cell cultures rather than in living animals. "This is the next logical step to try to bring ancient DNA into an animal or biological system," says Stephan Schuster, a genomicist at Pennsylvania State University in University Park.

Researchers might use the technique to find regulatory elements that could make a chicken look like a dinosaur or an elephant look like a mammoth, he says. But such methods would not bring back dodos, dinosaurs and mammoths. "If you had a very hairy African elephant, that would be a first step to looking like a mammoth, but of course it wouldn't be a mammoth. It would just be a weirdlooking elephant," Schuster says.

> Even though the thylacine enhancer seems to work the same as the mouse enhancer, mice and marsupials are so different that sometimes enhancers in mice might misbehave, giving researchers the wrong impression about how such bits of DNA worked in the extinct animals, comments Carles Lalueza-Fox, a paleogeneticist at the University of Barcelona. (1)



Tasmanian tigers, or thylacines (above), became extinct in 1936. Now scientists have inserted a piece of thylacine DNA into mice (an embryo shown at top), where it drives production of a marker gene (blue). The DNA turns on the marker in cells that produce cartilage.

# Genes & Cells

# What a tangled protein web humans weave

Complexity depends more on network of interactions than on number of genes

# By Patrick Barry

Humans don't have many more genes than fruit flies or roundworms, but the network of protein interactions in human cells is much larger and more complex, a new estimate shows.

While people have fewer than 25,000 genes, the proteins encoded by those genes interact in roughly 650,000 ways. That network of interactions, or "interactome," is about 10 times larger than that of the fruit fly and three times the size of the roundworm's interactome.

"The research is clearly quite exciting because it seems to reconcile an observation that has bugged many scientists, which is that the complexity of an organism does not relate in any simple fashion to genome size or gene number," com-



For more Genes & Cells stories, visit **www.sciencenews.org** 

ments Sebastian Bonhoeffer, a theoretical biologist at the Swiss Federal Institute of Technology in Zurich.

"At least when we score on the basis of interactome size, the humans come out on top" in comparison with fruit flies and roundworms, Bonhoeffer says.

"I don't think that it was known that we would have 10 times as many interactions as the fly," says research team member Michael Stumpf of Imperial College London. "Generally, a list of components like protein-coding genes does not provide you with an appreciation of how they interact or work together — just like the number of entries in a phone book does not tell you how communicative people in a city are."

Diagrams of interactomes look a bit like webs made by deranged spiders. In the vast tangle of lines, each intersection point represents one kind of protein. A line between two proteins indicates that those two interact in some way: binding, altering, impeding or stimulating each other, for example.

Evolutionary changes to the gene that encodes a protein, or to the small molecules that cells tack on to proteins to tweak function, could enable the protein to interact with a greater number of other proteins. These changes would grow the web of interactions over time without

This small portion of the complete human interactome shows a network of 9,598 proteins and 61,600 interactions. Dots represent proteins and lines represent interactions between those proteins. Different colors denote different original sources of information.



increasing the number of genes. Morecomplex animals can also make more than one protein from a gene, which expands the web as well.

Stumpf and his colleagues developed new statistical techniques for estimating the size of the complete human interactome based on existing knowledge about part of the network. For the current estimate, reported in the May 13 Proceedings of the National Academy of Sciences, the researchers fed data on 1.346 interactions among 1,085 proteins into their equations. Based on this small amount of data, the wiggle room in their estimate was plus or minus about 50,000 interactions, or 8 percent of the total. As information on proteins and protein interactions increases, the estimate will improve, but the scientists showed that, mathematically, their technique gives the best estimate possible for any limited amount of data. "You can't do better," Stumpf says.

The team also estimated the interactome sizes for fruit flies, roundworms and brewer's yeast, all mainstays of genetics research. Comparing species' interactomes provides another way for scientists to explore the evolution of complex animals beyond just comparing the "parts list" of genes encoded in the genome. "More-detailed studies of how the interactome evolves and correlating this with characteristics that we view as complex - for instance intelligence, language and brain size - will yield exciting insights," comments Jotun Hein, a professor of bioinformatics at the University of Oxford in England.

While the interactome encompasses more of an organism's complexity than the genome alone, Stumpf says that comparing interactomes captures only part of the total difference in complexity between species. Interactomes deal exclusively with proteins, but other kinds of molecules such as small RNAs are also cogs in a cell's baroque machinery.

"It's much, much more than just the organization of protein interactions," Stumpf says. "There's so much we don't know. It's such an exciting time." ■

# Body & Brain



Share of triplet births in the U.S. in 2004 arising from assisted reproductive technologies, such as in vitro fertilization

# One is the healthiest number

# Method may identify best embryos for in vitro fertilization

# By Tina Hesman Saey

Researchers have taken fingerprinting children to the next level. A group at Monash University in Melbourne, Australia, is using DNA fingerprinting and other molecular techniques to identify viable embryos created during fertility procedures.

Such research could improve the chance a woman will get pregnant when only one embryo is transferred to her womb. Currently, many fertility clinics in the United States implant two or more embryos created during in vitro fertilization, often resulting in pregnancies with

multiple "test tube babies." Pregnancies with multiples carry risks for mother and child.

These risks include premature birth, low birth weight, cerebral palsy and other disabilities, as well as infant death and pregnancy complications.

"The goal is to have healthy children one at a time," says David Ball, an embryologist at Seattle Reproductive Medicine.

But many people who have fertility problems are willing to have multiple embryos implanted in order to increase the chance of getting pregnant. "Patients look at it as they're paying a lot of money and they want to be sure it works," Ball says. "They'd rather have two [babies] than none."

Doctors cannot definitively distinguish which embryos will result in pregnancy and which will not, says Richard Paulson, a reproductive medicine specialist at the Keck School of Medicine of the University of Southern California in Los Angeles.

Fertility clinics examine embryos under a microscope and discard those that have obvious abnormalities, but several labs are moving toward molecular methods to identify the best embryo from the bunch. Paulson, who was not involved in the study, is testing the nutrient solution in which embryos are grown to see if healthy embryos make substances that distinguish them from unhealthy embryos.

In the new study, Gayle Jones and her colleagues at Monash and in Athens, Greece, extracted cells from embryos made during in vitro fertilization. The researchers could safely remove up to 20 cells from the outer layer of cells in a 5-day-old embryo. The embryos were then transferred to their mothers' uteruses. Some of the embryos developed into healthy babies. Others failed to implant in the womb or were not carried to full term.

DNA fingerprints of cheek swabs or

"The goal is to have healthy children one at a time." DAVID BALL umbilical cord blood from the full-term babies were matched to DNA fingerprints from the embryos to determine which embryos had been viable – offering direct feedback about which embryos produce healthy babies, Paulson says.

The researchers found that viable embryos turned on genes that encode cell adhesion molecules and cell communication proteins, the researchers reported online May 13 in an advance publication of *Human Reproduction*. Both types of molecules are likely to be important for the embryo to latch on to the uterine wall and grow.

The technique is still experimental and Jones and her colleagues aren't saying which genes are important for viability. "We have no confidence that we've found a predictive set of genes yet," Jones says.

Whittling the possible candidate genes down to a manageable number, fertility clinics could do viability tests to find optimal embryos to transfer. "We will be able to give clinics and patients confidence to accept single embryo transfers without affecting the pregnancy rate," Jones says.

"I don't think this is ready for prime time," Paulson says, "but I do think it's a very powerful research tool." (a)

# NEWS BRIEFS

## Brain remembers how to see

A study of two people who went blind while young and then partially regained sight as adults shows that blind people's brains remember how to see, essentially by allowing hearing circuits to share space with areas normally reserved for vision, report Melissa Saenz of Caltech and her colleagues in the May 14 Journal of *Neuroscience*. The two sight-restored people use the same brain area to decipher motion that is both visual (objects moving) and auditory (a car passing). The study suggests this brain area is "not a visual area per se; it's a motion area," comments Alvaro Pascual-Leone, a neurologist at Harvard Medical School in Boston. Learning how the brain uses its real estate may improve therapies for restoring vision and hearing, Pascual-Leone adds. — Tina Hesman Saey (

# Highs may hurt the heart

Add possible increased risk of heart disease to the side effects of smoking marijuana. A study led by Jean Lud Cadet of the National Institute on Drug Abuse in Bethesda, Md., and published online in Molecular Psychiatry tested blood samples from 18 chronic marijuana users and 24 nonusers. Heavy smokers, who used 78 to 350 joints a week, had higher levels of the protein apolipoprotein C-III, which stops enzymes from chewing up triglycerides. This failure increases the levels of triglycerides, implicated in heart disease. Chronic use may boost levels of the protein when THC, marijuana's active ingredient, binds to cannabinoid receptors in the liver, says George Kunos of the National Institute on Alcohol Abuse and Alcoholism in Bethesda. The body also makes substances that bind to the receptors. Understanding how THC works can shed light on this natural pathway, Kunos adds. — Tia Ghose 📵

# Atom & Cosmos

# A special place in the universe

# Scientists propose tests of Copernican principle

# By Ron Cowen

For all the hand wringing among physicists about the nature of dark energy, the invisible stuff that appears to be revving up the rate of cosmic expansion, a nagging possibility remains. Dark energy could be a cosmic mirage - if humans live in a special place in the universe having a peculiar distribution of matter.

If Earth and its environs are centered in a vast, billion-light-year-long bubble, relatively free of matter, and that bubble is surrounded by a massive, dense shell of material, then gravity's tug would cause galaxies inside the void to hurtle toward the spherical concentration of mass, say theorists Robert Caldwell of Dartmouth College and Albert Stebbins of the Fermi National Accelerator Laboratory in Batavia, Ill. That process would mimic the action of dark energy – a local observer would be tricked into thinking that the universe's expansion is accelerating.

But that scenario violates the Copernican principle, a notion near and dear to the hearts of physicists and cosmologists, including Caldwell and Stebbins. Named after the 16th century astronomer Nico-

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

laus Copernicus, who made the then heretical proposal that Earth does not have a favored, central position in the solar system, the principle states that humans are not privileged observers in the universe, but have just as good – or bad – a vantage point as any other observer in the cosmos.

"Although the Copernican principle may be widely accepted by fiat, it is imperative that such a foundational principle be proven," Caldwell and Stebbins assert in the May 16 Physical Review Letters. The researchers suggest a concrete way to check whether our neck of the cosmic woods is different from other parts of the universe. Their test relies on the cosmic microwave background radiation that bathes all parts of the universe.

If Earthlings were at the center of a bubble, the spectrum of microwave background radiation that came directly to Earth-without reflection-would trace a blackbody radiation curve. A blackbody emits all light that falls on it, and its spectrum depends only on its temperature (2.7 kelvins for the microwave background).

But another observer, not centered in the bubble, would see an asymmetric universe, with a matter-free region - the bubble - off to one side. This lopsided distribution of matter would leave its imprint on the microwave background. The photons would have various energies, depending on whether they originated in a high- or low-density region, and the resulting spectrum would no longer look like a blackbody's.

Two observers, two separate views of the universe, and never the twain shall meet. Except that the two views are not separate, Caldwell and Stebbins calculate. Electrons floating through the universe act like tiny mirrors, reflecting some of the microwave photons seen by other observers back toward Earth. If humans live in a special place, the microwave background will contain tiny deviations from a perfect blackbody spectrum.

Those deviations would be too small to show up in the most precise measurements of the microwave background recorded so far. But a proposed satellite, the Absolute Spectrum Polarimeter, could easily detect such deviations, says Alan Kogut of NASA's Goddard Space Flight Center in Greenbelt. Md. The mission could be launched next decade.

In the same issue of *Physical Review* Letters, Jean-Philippe Uzan of Pierre and Marie Curie University in Paris, along with Chris Clarkson and George Ellis of the University of Cape Town in South Africa, suggest a different way to test the Copernican principle.

As dark energy speeds up cosmic acceleration, the recession velocities of galaxies would change, as indicated by a shift in wavelength of their light to redder wavelengths, the scientists note. By measuring both redshifts and distances to remote galaxies over a 10-year span, astronomers should be able to tell whether we live in a Copernican universe. 📵



# Lines in the ice suggest massive flip on Europa

Imagine a shift in Earth's continents so extreme that Alaska would move to the equator. Astronomers have found evidence that such a shift actually happened on Jupiter's moon Europa. The sliding of the moon's icy shell - some 300,000 trillion metric tons - is further evidence that an ocean lies beneath the ice. This possibility ups the odds that Europa has a subsurface habitat that could support life, says Paul Schenk of the Lunar and Planetary Institute in Houston. He and his colleagues used data from three spacecraft - Voyager, Galileo and New Horizons - to map arc-shaped depressions on Europa. The large depressions, like the one indicated here by arrows, are about 500 kilometers long and shallow enough that "you would not notice them if you were walking on Europa," Schenk says. His team reported in the May 15 Nature that the surface scars have just the right shape, size and location to be fractures generated if the moon's icy shell had sometime in the past rotated by 80° – nearly a quarter-turn. – Ron Cowen 📵

# Science & Society

# **Students show their smarts at international science fair**

Participants compete for \$4 million in prizes

# By Rachel Ehrenberg

More than 1,500 young scientists from 51 countries, regions and territories flexed their mental muscles in Atlanta May 12–16 at an event of Olympic proportions. Three students took home the gold.

All together, \$4 million in scholarships, tuition grants and scientific trips and equipment were at stake at the Intel International Science and Engineering Fair, the world's largest high school science competition. The top three students won \$50,000 scholarships from the Intel Foundation.

Natalie Saranga Omattage of Cleveland, Miss., won for developing a quick and efficient method to screen food for additives and contaminants. Her biosensors were based on the quartz crystal microbalance, which involves instruments that are portable, relatively inexpensive and easy to use.

Sana Raoof of Muttontown, N.Y., won for her research into the Alexander-Conway polynomial invariant for chord diagrams, work that sheds light on a branch of mathematics known as knot theory. Her research could help resolve biochemical problems, such as identifying tangled DNA and figuring out how proteins fold themselves into their precise shapes.

Yi-Han Su of Taipei, Taiwan, won for a study demonstrating efficient generation of hydrogen from methanol. She created a copper-zinc-aluminum-based catalyst that had a high surface area and low reduction temperature and got more hydrogen from methanol than do current conversion methods.

Other top prizes included the Seaborg Award, named for the late chemistry Nobel laureate Glenn T. Seaborg, a former trustee for Society for Science & the Public, which runs the competition and publishes *Science News*. Recipients earn an

all-expense paid trip to the Stockholm International Youth Science Seminar in Sweden and entry to the Nobel Prize ceremonies. Three students won Seaborgs: Kaleigh Anne Eichel of Strongsville, Ohio; Dongyoung Kim of Anheung Gangwon, South Korea: and Eric Nelson Delgado of Bayonne, N.J. Eichel's work focused on learning and communication in comet goldfish, Kim created an algorithm that simulates water flow in three dimensions and Delgado developed a way to interfere with the pumps bacteria use to expel antibiotics.

Two projects won det \$25,000 awards from the office machine company Ricoh.

Erica Elizabeth David of Pinedale, Wyo., won for her work designing fences that capture snow for water conservation. Michael Kaergaard Madsen and Jesper Lykke Rasmussen of Vejle, Denmark, won for developing a prototype of a two-cycle engine that pushes unused gas back into the cylinder so that it is burned instead of wasted.

In case the students weren't starryeyed enough after their week in Atlanta, through a partnership between Society for Science & the Public and MIT's Lincoln Laboratory, the names of the first and second place winners in each of the fair's 18 categories will be submitted to the International Astronomical Union for naming rights of a near-Earth asteroid.

"Projects presented at the Intel ISEF demonstrate how the next generation is capable of rising to the great global



Yi-Han Su (left), Natalie Saranga Omattage (center) and Sana Raoof (right) each won a \$50,000 scholarship. The 17-year-olds investigated catalysts for generating hydrogen, biosensors that detect food contaminants and mathematical knot theory.

challenges of our time. Their research demonstrates profound curiosity, intelligence and discipline," says Elizabeth Marincola, president of Society for Science & the Public. "The economic health of any developed country depends on its investment in science and technology, and we are proud to reward and celebrate the contributions of these talented young scientists to our common future."

Since 1997 Intel Corp. has partnered with Society for Science & the Public in sponsoring the fair. Agilent Technologies was this year's presenting sponsor.

"You represent the best and brightest of your countries, communities and your schools," Brenda Musilli, Intel Corp.'s worldwide director of education and president of the Intel Foundation, told ISEF participants at the grand awards ceremony on May 16. "The world is depending on you to fuel the innovation of tomorrow."

# our undiscovered UNIVERSE

O U R

UNDISCOVERED

UNIVERSE



# Introducing Null Physics The Science of Uniform and Unconditional Reality

# TERENCE WITT

Theoretical physics has been hopelessly stalled for over 30 years. Moribund. Ossified. The Standard Model of particle physics uses over 20 ad hoc constants, and no one knows why they are necessary or why they have the values they do. Quantum physics and general relativity remain utterly incompatible. Cosmologists haven't the foggiest idea what could have caused the Big Bang or what, if anything, came before it. And finally, after over 30 years of effort, string theory hasn't even achieved the status of *science*.

There is a very simple reason for this catastrophic, intractable mess. Theorists stopped asking *why* a long time ago. Without the *why*, the search for mathematical symmetries becomes numerology, not science. No telescope or particle accelerator, regardless of its size, is going to tell us *why* the universe is the way it is. When the *why*'s remain unanswered, there is no understanding. When there is no understanding, there is no progress. But this sad situation is about to change forever.

*Our Undiscovered Universe* is all about the *why*. It's an entirely new paradigm, a premise so powerful that it can finally answer the most important question of all: *"Why does the universe exist?"* This, in turn, reveals many of nature's secrets to a depth and clarity never before imagined.

# Unified A Rational A Revolutionary A Empirically Validated

100 years ago, Einstein found a small part of the universe's four-dimensional geometry. Null Physics provides the rest of it. After reading this book, concepts like string theory and the Big Bang will seem positively ludicrous in comparison. Here is a brief glimpse of its sweeping unification:

- > Energy is a three-dimensional substance, and its most basic unit is time-distance<sup>2</sup>.
- > Our universe has only a single fundamental constant: its finite, four-dimensional volume.
- > A black hole's peak density is 1.2(10)<sup>19</sup> kg/m<sup>3</sup>, about 60 times more dense than atomic nuclei.

# Welcome to 21<sup>st</sup> century physics



Are you ready for an incredible journey? **nullphysics.com** 

479 pages, hardcover, \$59. Available exclusively at nullphysics.com. © 2007 Aridian Publishing Corporation, (877) 274-3426

# Insects



Bug bite: This grasshopper, called inago and marinated in a soy-sugar sauce, is served as an appetizer in a Tokyo restaurant.

# the original white meat by Janet Raloff • Photographs by Peter Menzel

You bite into a piece of candy and find a cricket leg. Eewwww. Or notice that raisin in a bowl of cereal has legs and wings. Bam, down the disposal it goes. Such filth in foods is supposedly illegal, but the Food and Drug Administration's actual tolerance is far from zero. FDA rules allow up to 60 insect fragments on average in a composite of six 100-gram chocolate samples. For peanut butter, it's OK to have up to 30 insect pieces per 100 grams. Grossed out yet?

In the industrialized world, most people find the idea of eating insects repugnant. Processed foods containing bug bits tend to reflect poor sanitation. Because bugs can host disease-causing germs, insects tainting the food supply pose a health risk.

Yet in many parts of the world, diners actually desire insects. Youngsters in central Africa may down ants or grubs while at play. Urbane snack-seeking consumers throng street vendors throughout Southeast Asia to buy fried crickets. Even car-driving Aborigines in Australia's outback may motor a couple of hours to find, and then picnic on, a cache of honey ants.

Residents of at least 113 nations eat bugs, says Julieta Ramos-Elorduy of the National Autonomous University of Mexico in Mexico City. This practice, known as entomophagy (en-toh-MOFF-uh-jee), makes sense, she says, because insects tend to be quite nutritious. Indeed, many scientists around the world have put insect eating on their research menus. It was also the focus of a February United Nations conference in Thailand, where researchers discussed insect-eating trends and evaluated the nutritional value of bugs and the environmental aspects of entomophagy.

"We're not going to convince Europeans and Americans to go out in big numbers and start eating insects," concedes conference organizer Patrick B. Durst. However, fostering respect for entomophagy could do a lot to maintain health and environmental quality outside the industrial West, argues Durst, a senior forestry officer with the U.N. Food and Agriculture Organization's regional office in Bangkok.

He holds out hope that Westerners may become more accepting of insect protein — especially if they "don't have to look the bug in the eye as they're eating it." Dutch researchers are working on just such a development — biotechnology to produce insect cells, minus the insects, as an inexpensive source of edible protein.

Almost 125 years ago, Vincent Holt published a 99-page tract in Britain titled *Why Not Eat Insects*? It failed to catalyze a bugeating revolution. David Gracer, a community college writing teacher by day, has now taken up Holt's cause outside the classroom. Not only does Gracer travel the lecture circuit, he also holds cooking demonstrations so that Americans can sample insect-based snacks and bug-laced entrees. His company, Sunrise Land Shrimp, in Providence, R.I., supplies frozen and dried insects to chefs and other individuals.

Grilled cicadas are more likely to elicit a "yikes" than a "yum" from most Europeans and North Americans. "But why?" asks Gracer. "Most of these people are happy to eat crab, lobster and shrimp — the ocean equivalent of insects."

Shrimp, other crustaceans and insects are all arthropods — members of the largest phylum in the animal kingdom. When people appear squeamish about tasting a grasshopper or beetle larva, Gracer points out that despite lobster's prized status, crustaceans tend to "eat trash and dead things" whereas most insects dine at nature's salad bars.

# A matter of taste

Edible insects fill a rather small niche market in the United States, Gracer concedes. Throughout most of the developing world, by contrast, dining on bugs is not only a time-honored tradition but often a treat.

That's something biologist Gene R. DeFoliart has explored for 33 years, first as chair of the University of Wisconsin-Madison's entomology department, and more recently as host of the food-insects.com website. Since retiring 17 years ago, he has been compiling data on entomophagy. His site offers a bookin-progress with 28 chapters.

Westerners tend to consider insect eating a last resort; you choke down bugs only if there's no chicken or beef available. Throughout the tropics and subtropics, however, certain insects, such as adult termites or various grubs, can be preferred to the flesh of birds, fish or traditional meat animals, DeFoliart has found.

Entomophagy thrives in Mexico, where Ramos-Elorduy has cataloged some 1,700 species that are eaten. Although grasshoppers are especially popular and inexpensive, diners in Mexico's bigger cities will shell out \$25 U.S. for a plate of maguey worms, larvae of the giant butterfly Aegiale hesperiaris, "Cows and

DeFoliart notes.

This reflects the fact that insects "now have a clear place in industrialized societies since chefs of different nationalities cook them in very sophisticated ways," Ramos-Elorduy contends. In Mexico, she finds that "the great demand is for five-star restaurants." Small bistros tend to serve insects seasonally, she says, but "the five-stars do it daily."

Throughout much of Africa, mopane (moh-PAH-nee) worms - caterpillars of Gonimbrasia belina, a moth that feeds on mopane trees - are a spectacularly popular snack. In fact, people have been eating so many that biologists have begun worrying that these bugs might be headed for

extinction. Sales of dried mopane worms in South Africa alone can exceed 1,600 metric tons per year, DeFoliart found.

Because the caterpillar metamorphoses in soil, it used to be "taboo to dig the worm that has gone underground," notes O. Ricky Madibela, formerly at the Botswana College of Agriculture in Gaborone. Today, however, people excavate dirt around mopane trees for this "seed of the next generation" of caterpillars. And that, he argues, is unsustainable.

In many regions, however, once-popular entomophagy is waning. Evidence for this shift emerged in Ecuador while entomologist Andrew B.T. Smith of the Canadian Museum of Nature in Ottawa and Ecuadorian Aura Paucar-Cabrera of the University of Nebraska-Lincoln, were studying the scarab *Platycoelia lutescens*. For the project, Paucar-Cabrera interviewed 48 residents in and around Quito about this white beetle's role in the local diet.

Everyone recognized the Andean insect – called *catso* 

blanco – as a culinary flavoring. And the 24 people from the rural and urban working classes all said they ate the beetles at least once a year. Some took their entire families out to nearby meadows in late October or early November to catch adult beetles emerging after metamorphosis in the soil. But among the 24 wealthier families and professional adults surveyed, only one admitted trying the beetles. The rest professed no interest in ever doing so.

Similarly, teens and young adults in Kenya's Luo tribe tend to view eating bugs as so last-century, notes food scientist Francis O. Orech of the University of Maryland Eastern Shore in Princess Anne. A Luo himself, Orech recalls eating ants and termites as a child. Now, to interview some 30 Luo about entomophagy, he and a largely Danish group of researchers had to consult people over age 45 to find individuals who still knew where to reliably find bugs, how to catch them and how to prepare them for eating.

## **Better than beef?**

The five species most widely eaten by surveyed Luo were ants, termites and a species of mondo cricket. All were good sources of minerals, but the crickets were the richest and an ant species the poorest, Orech's group reported in the International Journal of Food Sciences and Nutrition in 2006.

In fact, the team found that crickets contained more than 1,550 milligrams of iron, 25 milligrams of zinc and 340 milli-

> grams of calcium per 100 grams of dry tissue. Traditional cuisines in developing countries often fall short of the global guidelines for these minerals. Based on analyses of Luo-caught insects, just three crickets would provide an individual's daily iron requirement.

> Gram for gram, crickets or grasshoppers can be more nutritious than an equal quantity of beef or pork, says Victor B. Meyer-Rochow of Jacobs University in Bremen, Germany. One reason: Water constitutes a high percentage of meat, he says, whereas insects tend to be drier. Many insects also are richer in minerals than many meats, such as hamburger, his data show. And most lipids in bugs tend to be long-chain, unsaturated fats - healthier

types than those predominant in conventional livestock.

A comprehensive survey of bug nutrients appears in the 2005 book Ecological Implications of Minilivestock: Potential of Insects, Rodents, Frogs and Snails. It reports published values for calories, protein, fat and fiber in most major species of edible insects. Additional tables summarize the potential of these bugs to contribute important amino acids, minerals, healthy fatty acids and vitamins to the diet.

The data were gleaned by Sandra G.F. Bukkens, now an independent nutrition consultant based in Barcelona, Spain. Overall, she says, "I was pleasantly surprised. Insects were far more healthy than I expected."

Many insects had a fairly high concentration of essential amino acids – types that humans need but can't make. These include lysine and tryptophan, two that tend to be limited in traditional diets in the developing world. The quality of insect

pigs are the SUVs of the food world. And bugs they're the Priuses, maybe even bicycles." DAVID GRACER



**Top Left:** A family in South Africa shares a breakfast of mopaneworm stew. Dry, these crispy moth larvae taste salty and a bit like sawdust. Cooked, they pick up the flavor of other ingredients and become chewy, like tough portobello mushrooms. **Top Right:** Middleschoolers in the California Bay Area get a cooking lesson from entomologist Leslie Saul, then at the San Francisco Insect Zoo, and her husband. **Above:** Aquatic larvae, called *zazamushi*, are laid out to be cleaned of river debris. Japanese hunters must be licensed to capture the insects, which are sautéed with soy sauce and sugar and served as an appetizer.



In the Abastos market in Oaxaca, Mexico, piles of grasshoppers, called chapulines, are for sale along with fresh produce.

proteins is usually good too, compensating, Bukkens says, for what is lacking in largely vegetarian diets.

Despite this upbeat assessment, Bukkens isn't pushing insects on her family. "I've eaten them, but I'm not particularly keen about them," she says. If food were limited, she would "eat anything. But since we have plenty of meat in developed countries, I don't see why we should switch to insects."

Even DeFoliart, whom many refer to as Mr. Entomophagy, admits to never cooking insects at home. In fact, his daughter once cajoled her mother into sampling a roasted cricket. When his daughter offered mom a second, DeFoliart recalls with a chuckle his wife's reply: "Oh no, I'll have to rest awhile."

# **Clean and green**

Diners who want to reduce the size of their environmental footprint might reassess their aversion to bugs, DeFoliart says. Insects typically eaten by people are vegans — at least for much of their life cycles, he says — and generally "clean-living in their choice of food and habitat." Moreover, edible insects can forage on a far wider range of plants than do traditional meat animals. As such, he says, bugs can tap food sources normally worthless in conventional meat production, such as cacti, bamboo shoots, mesquite and woody scrub brush.

What's more, insects turn more of what they eat into tissue that can be consumed by others. For crickets fed diets compa-

rable in quality to the feed given to conventional Western livestock, diet conversion efficiency is about twice as high as for broiler chicks and pigs, four times higher than sheep and nearly six times higher than steers, DeFoliart reports. Insects' quick reproduction and high fecundity makes them look even more environmentally attractive. For the crickets, DeFoliart has calculated, this translates into "a true food conversion efficiency close to 20 times better than that of beef."

Gracer likens these differences to gas-guzzling versus gassipping vehicles: "Cows and pigs are the SUVs of the food world. And bugs — they're the Priuses, maybe even bicycles."

And bugs can be raised sustainably, the U.N.'s Durst says, pointing to an industry that has sprung up in northeast Thailand since 1999. Entomologists and agricultural extension agents at Khon Kaen University developed low-cost, cricket-rearing techniques and offered training to local residents. Currently, 4,500 families in Khon Kaen Province raise crickets, as do nearly 15,000 others elsewhere around the country, Khon Kaen entomologist Yupa Hanboonsong said at the recent meeting organized by Durst.

A single family can manage cricket rearing as a sideline activity without outside help, needing only a few hundred square feet of land. The 400 families in just two local villages produce some 10 metric tons of crickets in summer, the peak yield period. As the weather cools, yields may eventually fall by 80 percent or more. Still, that translates to extra, year-round income of U.S. \$130 to \$1,600 a month per family, Hanboonsong says. That's quite a windfall for residents of one of Thailand's poorer regions.

Most of their farmed crickets go to big city markets, like outdoor stalls in Bangkok. Hanboonsong says, however, that some are exported to neighboring cricket-consuming nations, such as Laos and Cambodia. Thai families also farm ants, another popular edible insect. And her Khon Kaen colleagues have just developed new rearing techniques for farming grasshoppers and the giant water bug (a Thai favorite). Indeed, Hanboonsong's survey of Thai insect consumers found that 75 percent eat bugs simply because they're tasty — especially as a snack with beer.

Bug farming gets around the problem that most insects are quite seasonal, Durst says. It also reduces pressures on wild populations. But data reported at his conference didn't turn up much evidence of insect overexploitation in Thai forests. In fact, he says there were suggestions that increased entomophagy might pay bonus ecological dividends. For instance, it might make local villages better stewards of their environment because of the potential for collecting marketable insects.

There was even talk of how people might be marshaled to harvest insects for food in areas plagued by pests, substituting people for pesticides to protect crops.

It's not far-fetched.

Hanboonsong reported that when chemical insecticides didn't rout locusts from corn fields 30 years ago, the Thai government launched a campaign (including recipes) to collect and eat the pests. Although locusts had not previously been among the 150 species of bugs in the Thai diet, residents took up the challenge. Today, locusts are no longer a pest, and some farmers now plant corn as bait for the bugs, which they supply to local markets.

# **Biotech bug burgers**

Durst suspects that two major facets of insects continue to turn many American and European diners off: concerns over hygiene and the fact that the critters look like — well, bugs. Hygiene can be dealt with by cleansing the outside of bugs thoroughly and emptying or even removing their guts. More difficult is camouflaging their antennae, buggy eyes and legs,

# Audubon's insect cafeteria

Would you fancy grasshopper gumbo? Perhaps mushroom hors d'oeuvres topped with a batter-dipped and lightly fried dragon-fly—in season, of course—drizzled with a sauce of Dijon mustard, soy and butter?

These are among recipes that self-taught insect chef Zack Lemann has whipped up as possible menu items for Bug Appétit. This restaurant offering bugged dining will be a permanent feature of the Audubon Nature Institute's Insectarium. Celebrating insects and other arthropods, the 23,000-square-foot museum will open June 13 in New Orleans.

"For the tentative gourmand," Lemann says he might produce chocolate-covered bugs or cookies garnished with toasted crickets. or perhaps the fact that some look like soft, overly puffy worms.

Dutch scientists think they may have a solution to both impediments. They're using biotechnology to produce vats of insect cells – just isolated cells. The researchers described their efforts last year in *Biotechnology Advances*.

The goal, explains Marjoleine C. Verkerk of Wageningen University, is to produce a sanitized source of bug proteins that can be dried and added to breads or perhaps molded into pseudoburgers. Her team is mass producing isolated ovary cells of silkworms, fall armyworms, cabbage loopers and gypsy moths.

Grown in a bioreactor, these cells won't support the growth of viruses or turn on cancer-triggering genes, things they could do in a whole bug, her group notes. As the researchers analyze the nutrient content of these cells, Verkerk has also begun to survey consumer attitudes on fortifying conventional fare with insectderived materials. It remains a bit of a tough sell, she admits.

A Japanese consortium has a more far-out use for insects: space food.

Although trained as a chemist, these days Masamichi Yamashita says, "I prefer to be called a 'space farmer' wishing to fly to Mars." At 60, he's unlikely to be called up as an astronaut. So he's doing the next best thing. Through his work at Japan's Institute of Space and Astronautical Science in Sagamihara, he's helping design a habitat that will allow future generations to survive years aboard cramped spacecraft or planetary outposts.

Key to the effort will be integrating bugs as a potential source of food and of natural plant-waste recycling for astronauts, his team argued a few months back in *Advances in Space Research*. He and his colleagues are developing an ecosystem that includes pupae of silkworms and hawk moths as sources of food. These metamorphosing insects — especially the silkworms — are popular in Japan and other parts of Asia.

Their taste? "I ate soft-shell crab in Washington, D.C., once," Yamashita says. "That might be close." ■

## **Explore more**

- Gene R. DeFoliart on insects as food at www.food-insects.com.
- Find out more about the new Insectarium at the Audubon Nature Institute in New Orleans at www.auduboninstitute.org.

More daring diners might opt for red beans and "yikes," he suspects, which is rice seeded with poached wax worms that "are ricecolored and rice-shaped, but quite a bit bigger." In many instances, people will see the bug but not really taste it. Certainly, he says, "we won't try to hide the bugs."

Curious diners who can't make it to New Orleans can sample insect-laced cuisine at events such as Cornell University's fall Insectapalooza, the North Carolina Museum of Natural Sciences' autumn BugFest or Purdue University's spring Bug Bowl.

Or, cooks can experiment at home using insects normally destined to become food for pets like reptiles. Lemann contends that nutty-flavored crickets, in particular, can be substituted in any recipe that calls for small chopped pieces of fruit, vegetables, meat or nuts. *— Janet Raloff* 





# Parallel universes aren't supposed to be observable, but a cosmic crash might leave a visible sign of their existence

**BY DIANA STEELE** 



cience fiction movies and books are full of parallel universes.

In a typical scenario, as in the movie *Sliding Doors*, something happens in one universe — like a woman misses a train — but

in a parallel universe, the same woman catches it, setting in motion diverging life paths.

Or, as in Isaac Asimov's imaginative novel *The Gods Themselves*, alien inhabitants of a parallel universe with different physical laws exchange energy with our universe and send coded messages to Earth.

Even without any real-life alien messages to decipher, though, many cosmologists believe that there really are other universes out there. It's just that their existence has long seemed more of a philosophical speculation than a testable hypothesis. Seeing such universes directly would require exceeding the speed of light – a violation of the laws of physics better left to the science fiction writers.

Now, however, some cosmologists suggest that even though we can't communicate with another universe,

there might be a way to discern a sign of its existence if it collided with ours. Such a cosmic impact might leave its mark in the cosmic microwave background — our earliest snapshot of the origin of the universe.

"I think that's a really, really fascinating idea," says MIT cosmologist Max Tegmark. "Although the evidence has been mounting that parallel universes might exist, I think there's been a feeling of resignation that they might remain just parallel universes that you could never touch, never see directly. And now suddenly comes this idea in from left field, suggesting not only that it might be possible to see them, but even that we might already have seen them, imprinted in the cosmic microwave background."

Two groups, one led by Anthony Aguirre of the University of California, Santa Cruz, and the other by Matthew Kleban of New York University, posted papers online in December proposing the possibility of observing those ultra-cosmic collisions. Each group suggests that the collisions might be visible, although the details of what the signature might look like have yet to be worked out.

## Inflating, eternally

Preposterous as parallel universes might seem, their existence may be an inevitable consequence of the physics behind the Big Bang birth of the universe. Cosmologists believe that shortly after our universe began, a brief period of rapid expansion, called "inflation," enlarged it by many orders of magnitude, like blowing a tiny bubble of foam up to the size of a hot-air balloon.

Most of inflation's testable theoretical predictions have been confirmed. "There's a sense in which inflation is a key and somewhat indispensable part of our current understanding of how our universe began and evolved," Aguirre says.

But the theory, proposed by MIT cosmologist Alan Guth in 1981, also implies that inflation didn't just happen once, in our part of the cosmos, but rather keeps happening, inflating other patches of space like bubbles forming in a pint of beer.

This "eternal inflation" creates other "bubble universes" that likely have different properties from our own universe in terms of cosmological quantities and even physical laws. In some bubbles, the electromagnetic force might be so weak that it can't hold atoms together, or the expansion rate might be so fast that galaxies can't form.

The multiple universe consequence of inflation is hard even for scientists to wrap their minds around.

"Most people ignored this carefully for 20 years or so because they didn't want to think about it," Aguirre says. "They like to think of inflation as this little interlude. So most people ignored this idea. Although most of the people who invented inflation kept thinking about it because they saw that it was important."

Cosmologists haven't been alone in postulating multiple universes. String theory suggests that our universe contains extra dimensions, most of which are curled up and so tiny we can't see them, but that underlie our particular set of physical laws. Many scientists wondered why our way of curling up the extra dimensions should be the only possible way.

In string theory, another universe

Microwave radiation traveling across the universe appears mostly uniform—as shown in the larger sphere—except for tiny temperature variations (red and blue) that indicate the locations of the seeds of future galaxies and other structures. Some cosmologists now say that if, in the formation of the early universe, another "bubble" universe—the smaller sphere—collided with our own, the collision might have left its mark on the cosmic microwave background radiation.

could have as many as 10 dimensions of space, with seven curled up. The types and masses of fundamental particles, as well as the varieties and strengths of fundamental forces, could vary in an uncountable number of ways.

String theory predicts just the sort of eternal inflation that "will create lots of different universes," says Aguirre, "or regions where inflation stops, but they'll correspond, each of them, to different ways that those extra dimensions are curled up, and have different properties for the universe that they form."

From the inside, each of these universes appears infinite. So the woman who missed the train in her universe can never know about the woman who caught it in the other — in a sense, she's trapped in her bubble. "So it seems like the hypothesis that there are other bubbles out there with different properties is just speculation or metaphysics or fantasy," Aguirre says.

# When bubbles meet

However, kind of like the foam in a sink full of soapy water, these bubbles could run into each other. For a long time scientists thought that these collisions almost certainly happen but that the chances of seeing one would be rare. Or if you did see one, it would be fatal. "The bubble running into our bubble would come into our bubble and destroy us," Aguirre says. "And since that obviously hasn't happened, there's some reason."

With those things in mind, Guth, Jaume Garriga and Alex Vilenkin calculated how likely it would be to see a bubble collision in our observable region of the universe — which is just a tiny part of one bubble. They posted their paper online in December 2006 at arXiv.org.

"We concluded that most observers in bubble universes live very far away from the collision regions and will not see any signatures of the collisions," wrote Vilenkin, of Tufts University in Medford, Mass., in an e-mail interview. He said they assumed that new bubbles form at a slow rate, so "bubble collisions are not very frequent."

That means the woman on the train would never know if her bubble crashed into the bubble containing the woman who missed the train, because the first woman is too far away from the place where the bubbles hit. Even if the collision destroyed part of one of the bubbles, the unaffected region each woman sees would still look infinite from her standpoint.

On the other hand, a collision might just wipe out the other bubble altogether.

Aguirre and his collaborators took another view. "Why should one of those collisions necessarily be so devastating?" he wondered. And what if a gentle collision happened close enough that you could actually see it?

In a paper published online at arXiv.org in April 2007, they tried to imagine what the collision would look like. "It's sort of a disk on the sky," Aguirre says, which "might be infinitesimally tiny in some cases, or the whole sky in other cases."

But a question remained about when bubble collisions would be fatal to the observer. "And when might they just 'ping' the bubble the observer is in, not really disrupting it too much, but leaving some kind of signature?" Aguirre says, an indicator that someone in the bubble could see and say, "Oh look, there's another universe."

This is the scenario postulated in the paper he and postdoctoral researcher Matthew Johnson of the California Institute of Technology in Pasadena published on arXiv.org in December 2007.

They found in many instances a collision wouldn't necessarily be fatal, but might be seen as a disturbance of the microwave background. What exactly it would look like, Aguirre says, isn't something they've been able to calculate — for example, if the "ping" would cover a large or small area on the sky. But if it was just one bubble, or even if it was many bubbles, it would appear to come primarily from one direction.

Imagine just one bubble bumping up against another, the situation NYU cosmologist Kleban and his collaborators considered in their paper, published on arXiv.org just days before Aguirre's second paper. "If you're inside one of them," says Kleban, "obviously there is one direction where one bubble came from, and you'll see something special in that direction."

Oddly, that anisotropy — a greater signal from one direction than the other — would be the same even if there were multiple bubbles. Only in the extremely unlikely scenario that Earth occupied the exact center of the cosmos would bubbles hit equally from every direction.

# A cosmic 'axis of evil'

Another way to think about it is that in this bubble model, the Big Bang started in a particular place in space and time, says Princeton University theoretical astrophysicist David Spergel. And "if we're liv-

ing to the north and right of that spot, in one direction of the sky we should see more collisions with other bubbles than in other directions."

Here's where the cosmic microwave background comes in. This radiation, left over from the Big Bang, has been cooled by the universe's expansion to about

2.7 kelvins, or degrees Celsius above absolute zero. It looks infinitesimally hotter and colder in spots, corresponding to the fluctuations in density of the early universe that led to the clumping of matter into galaxies. Up to now, the pattern of spots has appeared the same in all directions. But if Aguirre's and Kleban's speculations are correct, the cosmic microwave background would look perhaps slightly colder in one direction than in the opposite direction.

Tantalizingly, the most precise measurements of the cosmic microwave background to date, made by the Wilkinson Microwave Anisotropy Probe, or WMAP, satellite appear to hint at exactly that. "There is a bit of an anisotropy," Kleban says. "In particular, there is a big cold spot in one direction," which makes it look like the sky is rotating around an axis.

This anisotropy was dubbed the "axis of evil" by researchers João Magueijo of Imperial College London and Kate Land, now at the University of Oxford in England, in a 2005 *Physical Review Letters* paper.

Spergel, one of the investigators on the WMAP team, is skeptical. "I think the 'axis of evil' in the CMB is much like George Bush's 'axis of evil,' in that if you go into the data looking for something," he says, "you'll find something."

But other people are looking anyway. Last August, astronomer Lawrence Rudnick of the University of Minnesota in Minneapolis announced that he and his team, combing through data from the Very Large Array radio telescope near Socorro, N.M., found a giant void, nearly 1 billion light-years across. The void, centered on the WMAP cold spot, appears to be largely empty of galaxies or dark matter.

That's about what you'd expect if the cold spot is real. Such anisotropy might

"It's almost

like you

try to tune your

TV to static,

and you

keep being

interfered with

by sitcoms."

MATTHEW KLEBAN

indicate a bubble collision—or it might not.

Spergel contends that the hottest spot and the coldest spot on the sky in the cosmic microwave background lie within the plane of our galaxy, which, he says, "suggests that what we're really seeing is largescale variations in dust

properties within our galaxy, not something cosmological."

Kleban agrees that it's difficult to separate out the effects of interferences from within the galaxy. "It's almost like you try to tune your TV to static," he says, "and you keep being interfered with by sitcoms."

He adds that he doesn't yet know if a bubble collision would produce exactly the cold spot that may exist in the cosmic microwave background. Still, "the possibility, if it's right, is very exciting," he says. "It would really change our view of our place in the universe."

There's another possibility: a collision with another bubble hasn't happened — yet. If a devastating collision is in our future, says Kleban, "we're just squashed like bugs, and that's the end of us."

If two bubbles collide, the bubble wall between them would tend to accelerate toward one or the other bubble. "And if it accelerates towards us, then light or any other signal from the collision arrives just a moment before the wall itself arrives, and in that case, we're dead," Kleban says. "But one comfort is that there isn't very much warning." Happily, because of some of the particular properties of our universe, in most cases, the wall would move away from us, rather than into us, he says.

The next step is to better understand what theoretical models actually predict for the cosmic microwave background signature. "Much work remains to be done to reach any reliable conclusions, but the first steps made in Aguirre's and Kleban's papers are very important and interesting," wrote Vilenkin in an e-mail.

Tegmark is optimistic. "This is an example of something we've seen over and over again in science, where the borderline between science and science fiction shifts," he says. Atoms and black holes might have forever remained in the realm of science fiction, but new technology expanded the frontier of science and allowed them to be detected. Parallel universes, Tegmark says, "could be yet another case of something we thought was beyond science and ends up being within science." ■

Diana Steele is a science writer based in Ohio.

#### Explore more

 Alan Guth. The Inflationary Universe: The Quest for a New Theory of Cosmic Origins. Perseus Publishing, 1997.

www.sciencenews.org

# How they shine

Iridescence could be pretty meaningful or maybe just pretty By Susan Milius

Believe it or not, science has barely begun to fathom the peacock's tail. Subtle as a pink tuxedo, one might think. Bigflashy thing. Peahens love it. What's not to understand.

Roslyn Dakin, though, has plenty of questions. There's the matter of choreography. Already this year she has left Queen's University in Kingston, Canada, to visit peacocks (the birds) in Los Angeles and New York. She has spent weeks collecting feathers and watching males fan out their finery before the ladies. "The males do all sorts of strange footwork," she says.

With their tails a wall of shimmer, they sidestep or sometimes strut backward to their audience. Dakin is testing her idea that there's a method here. For the final act of the show, males vibrate the big eyebearing feathers so vigorously they make a rattling sound, and Dakin hypothesizes that the males' footwork maneuvers them and their audience to line up with the sun for the finale. A female with sun right behind her gets the most dazzling angle on the feathers, and for a peacock, angles are everything. The fiery greens and blues that have become a symbol of extravagant ornament have no green or blue pigment in them. There's black pigment, but the rest is all just the play of light.

The trick for conjuring colors out of nothing depends on structure at the scale of hundreds of nanometers. At this scale, the smallest branchings within peacock feathers reveal themselves coated with arrays of rods. When light bounces off, certain wavelengths combine to intensify a color as other wavelengths interfere with, and cancel out, each other. The effect of this symphony of light shifts with the angle of view, the definition of iridescence.

Dakin described her work in February at a conference on iridescence held at Arizona State University in Tempe. The physicists who attended have been discovering that birds, beetles, butterflies and plenty of other creatures evolved cutting-edge optical systems long before modern technology did. Dakin and other biologists are now trying to figure out what the animals

do with their light shows. These nanomarvels make excellent systems for testing ideas about how animal communication systems evolve.

One of the questions under lively debate at the meeting was whether iridescence has signaling power because it is difficult to manufacture or maintain. Only the best males would flaunt the brightest colors, and females would evolve to favor the flashiest fellows.

In contrast, Richard Prum of Yale University, a biologist at the conference, argues that searching for such clues to quality

A Morpho butterfly wing shines bright blue but contains no blue pigment. The intensity of blue varies as the butterfly flaps its wings, reflecting light at different angles. "At a certain point that blue color turns on like a bright LED light," says evolutionary biologist Nathan Morehouse of Arizona State University in Tempe.

could be just wishful thinking. Iridescent glitter could appeal to female animals all right. But the driving force for evolving that preference could have nothing to do with the male's health or any other quality. The majority of iridescence, he says, could be arbitrary, or "merely beautiful."

#### **Controlling color, naturally**

Mere prettiness is no slur on the marvels of iridescent structures. A longtime iridescence specialist, developmental biologist Helen Ghiradella of the University at Albany, State University of New York, has published pages and pages of scanning electron microscope images revealing huge variety in the fine details of the textures of animal surfaces: bumpy surfaces like rows of Christmas trees, fields of latticework honeycombs, bristles that work like fiber optic cables (but better). She reels off examples of the cutting-edge developments in optics that she has observed in nature: thin films, photonic crystals ordered in one, two and three dimensions, plus surfaces that combine techniques.

She protests the unfairness of questions about which species flaunt the showiest iridescence. When pressed, though, she offers examples that include the Southwest's scarab beetle *Chrysina gloriosa*. The naked human eye can't detect the full light show, alas, so people have to make do with admiring the beetle's shimmery green back. Equipped with the right instruments, though, an observer realizes that the beetle reflects the controlled spirals of both right- and left-handed circularly polarized light.

Even one of the field's old classics, the Morpho butterflies that Ghiradella studied during the 1970s, still hold surprises. In 2007, she contributed to a Morpho article in the February Nature Photonics published by a General Electric research team led by Radislav Potyrailo of the company's Niskayuna, N.Y., lab. Potyrailo had seen pictures of a Morpho wing nano-structure and realized that vapors of different gases should subtly alter the butterfly's iridescence. The GE team and Ghiradella analyzed the effects, which Potyrailo says suggest new options for developing sensors that change color with a whiff of a certain vapor.

Natural structures for controlling colors certainly should be an inspiration for engineers, and physicists should pay attention, says Andrew R. Parker of the University of Oxford in England. His group studies optical biomimetics, or nature-inspired technology. The animals' devices come from millions of years of evolutionary trial and error and, as he puts it, "the average physicist has rather less time."

# Wings of wood

Imitating nature isn't easy. Peter Vukusic, who estimates his research group at the University of Exeter in England has looked for these structures in 500 to 600 species of insects, still uses words like "unbelievable."

He and his Exeter colleagues have attempted to replicate the surface complexity of a butterfly wing. Starting almost a decade ago, they experimented with building large-scale models of these structures, at first just for show-and-tell but then in the hopes of doing experiments to understand the novel optical properties.

Vukusic, a veteran of restoring old houses, started trying to create repetitious elements in wood the way a router shapes chair rails. He wasn't even trying to build a whole wing, since he'd scaled up so much that a single butterfly would spread more than a kilometer.

Even at that extreme magnification, the skilled and inventive fabricators for Exeter's laboratories struggled to produce even grossly simplified versions.

Then, while driving home one day, Vukusic says, he "experienced a moment of clarity — suddenly the mist rises." Vukusic abandoned several years' worth of wooden butterfly parts and used a rapid prototyping system to bring wings into the era of computer-controlled polymer shaping. He and his colleagues finally created chunks of opaque white plastic that mimic a fleck of wing surface accurately enough for research purposes.

"This thing looks like a dinner plate," he says. At this large scale, the model bit of a *Morpho* butterfly wing, for example, holds shapes that resemble a row of white Christmas trees, each a few centimeters high. At this scale, the models do nothing to light but can manipulate the longer wavelengths of microwaves as stand-ins. Vukusic's team is using these models and microwaves to study how insect wings create a silvery effect. His models starred at the February workshop in Tempe.

# **Creative communication**

Animals might have a hard time with these specialized structures too. If they do, some biologists suggest that the challenges give iridescence its value.

In one scenario, the structures represent a handicap. Growing them might sap energy from other developmental processes. Or flying around as a living disco ball might stir up predators. Costly iridescence would become the male butterfly's Porsche, says Darrell Kemp of James Cook University in Cairns, Australia. In a related scenario, "iridescence is just plain difficult, not necessarily costly, for all males to generate, like a good sense of humor in human males," Kemp says.

Earlier work on what female butter-

flies like had resoundingly shown that color matters. When researchers blotted out the iridescent ultraviolet markings on the wings of male *Colias* butterflies, the researchers found that the males had a pretty lonely existence.

Yet Kemp argues these earlier experiments had created such drastic changes in male finery that researchers couldn't say in what way the color mattered. The female might have rejected the male because she no longer recognized him as the right species. He revised experimental procedures and worked with *Hypolimnas bolina* butterflies. The upper surface of their wings are iridescent in ultraviolet wavelengths, which females of that species can see. The males must look like flashing beacons as they flap their wings.

To avoid the extremes of earlier experiments, Kemp used a screening substance to dull the males' wings to about half their former UV brilliance. For comparison, he also blacked out the UV patches with a pen on some of the males. In tests in fields and enclosures, marked males failed to attract the attention that females bestowed on the full-UV fellows. The loss of brightness matters to female butterflies in choosing mates, he concluded last year in *Proceedings of the Royal Society B*.

A similar experiment finds the same dynamic in *Eurema hecabe* butterflies. Dulled males meet with less success in mating, particularly in attracting the supposedly more desirable large females,

A *Morpho* wing steers light into iridescence. Light hits the wing's nano-structures (scanning electron microscope image at left). Different colors will take different paths back out, steered by the structures' texture. The light waves (red dots) in the middle image are constructively interfering, moving such that they amplify each other and the wing appears intensely blue. Colors in the last image destructively interfere and cancel each other out.



Kemp reports in the January/February *Behavioral Ecology*.

So Kemp says he's convinced that females pay attention to males' iridescent light shows. Now he's working on understanding what kind of information those shows might contain. He has raised caterpillars under sorry conditions and checked to see if their displays changed. Both those that had to make do with skimpy rations and those that as pupae endured great swings of heat and cold grew poorly. As adults, their wings did not flash as brightly. Also, he noted that the iridescence seemed to diminish more than other traits he checked, such as pigment colors. Thus the intensity of iridescence could serve as a sensitive indicator of a male's history.

Peacock feathers carry a black pigment but no green, blue or brown. The shimmer and extra color arise from the play of light over arrays of minuscule rods in the feather's surface.

One theory had also proposed that color signals could carry information about genetic quality, perhaps identifying certain males with the built-in resistance to laugh off slings and arrows of developmental stress. Kemp looked for signs that clusters of related individuals looked pretty good despite the stresses. Nice idea, but in this case, no support.

Prum says he accepts that animals use traits like iridescence as signals. What he objects to is what he describes as a widespread presumption that signals routinely carry information pertinent to the decision at hand. Some human signals, like onomatopoeic words, do carry clues to their meaning. Pop, snap, murmur. But plenty of human signals, like the words *plenty of human signals*, don't. Genetic modeling, says Prum, shows that animal signals can easily arise without some innate relevant clue, such as a connection to male quality. So he hypothesizes that most animal signals will turn out to be like *plenty of human signals*.

#### Explore more

 Darrell J. Kemp. "Female mating biases for bright ultraviolet iridescence in the butterfly *Eurema hecabe* (Pieridae)," *Behavioral Ecology*. Jan./Feb. 2008.



# Feedback

A little gravity

"Britain's biggest meteorite strike" (*SN:* 4/12/08, p. 238) states that "gravitational anomalies" make an offshore area a prime candidate as the possible impact site of a meteorite. Wouldn't that be magnetic anomalies instead? If it is a gravitational anomaly, I would sure like an article on that alone! Thanks for the great magazine.

PETER LINDSAY, SEATTLE, WASH.

The craters from extraterrestrial impacts can create measurable gravitational as well as magnetic anomalies (SN: 6/15/02, p. 378), albeit exceedingly small ones. For the area off the Scottish coast, the local gravitational field is only 0.0013 percent lower than it is over nearby, presumably undisturbed, rocks, the researchers tell Science News. — SID PERKINS

# Good food for thought

I really enjoyed the article "What's Cookin'" on molecular gastronomy (*SN*: *3/29/08, p. 202*). I am a chowhound and cook, so there was honestly little in the article that I didn't already know, but it was a very well written, concise and comprehensive feature article — just what I look to *Science News* for. I can refer my friends to it — many have had trouble understanding the molecular gastronomy movement and think of it as some sort of popular fad. This article should help them out.

DAVID APPLEMAN, TEWKSBURY, MASS.

# Worst of both

Regarding "Shifting priorities at the wheel" (*SN: 5/10/08, p. 7*): For a number of years I have listened to (tried to listen to) lectures on CDs while driving. I quickly discovered that I would have to backtrack a CD when I was in a situation where I had to truly focus on my driving. I realized it was wisest to try to listen to spoken messages only when driving on major highways when traffic was not congested. The evidence keeps building that we are fooling ourselves if we think we can multitask without sacrificing attention, information acquisition or understanding.

CLINTON BROOKS, GLEN MILL, PA.

# Another gas-fill

We still cling to that very human invention, the dump, this time for carbon dioxide. Every solution discussed in "Down with Carbon" (*SN: 5/10/08, p. 18*) is a sequestration, a deep-sixing or other burial in an open-loop dump. Glaringly absent was any mention of a sustainable close-the-loop REUSE of carbon dioxide, such as algal biofuel. P.S. We do like the new *SN*! **TOM BINDRIM,** PISGAH FOREST, N.C.

# **Tangled web**

The new *Science News* format is delightful, but please don't attempt to extend the reformatting to biological taxonomy. "Spiders boost mercury levels" (*SN 5/10/08, p. 14*) discusses "spiders and other insects living near a mercury-contaminated river." Spiders are no more insects than humans are birds. **J.C. MCLOUGHLIN,** TAOS, N.M.

# What gull

You can add seagulls to the list of thieving birds ("Hatch a Thief: Brains incline birds toward life of crime," *SN: 12/15/07, p. 372*) — unless you already have. My grandson was the victim of seagull thievery at the San Diego Zoo, where seagulls move far enough inland to stalk folks carrying open bags of popcorn. They approach from behind or from the side and actually collide with the bag, causing some or all of the popcorn to be spilled on the ground, resulting in a swarm of waiting gulls that immediately clean up the entire mess.

ROBERT L. COONEY, RIO RANCHO, N.M.

# Cheers

"Hairy Forensics" (*SN*: *3/1/08, p. 131*) describes finding a person's origin and movements using isotopic signatures in peoples' hair, which match those in the water people consume, which mainly comes from near where people live.

While an interesting theory, chances are that using the technique would lead a researcher to conclude that I have spent the past 20 years or so living in or near a brewery in New Castle, England. JAN PAYNE, JULIAN, CALIF.

# More comments on the new Science News:

**44** We are fooling ourselves if we think we can multitask without sacrificing attention, information acquisition or understanding. **77** 

I use *Science News* in my high school every week. We put the magazine out in the media center and the kids are avid readers. Problem: The advertising in this first edition of the new format (*SN: 5/10/08*) makes the magazine useless in education. I am not asking you to restrict your advertisers, but you need to know that teachers can no longer use *Science News* if that kind of advertising is going to be emphasized.

Thank you for the best science articles I have found, and I hope my students will continue to be able to use them. If it is going to be adults only, then I will have to look for something else after all these years.

# ANN MARIE WELLHOUSE, CAMPO, CALIF.

Science News will no longer accept such ads.

As a science hobbyist, I have subscribed to Science News since 1975. Regarding the new format, I like the low glare paper. Comparing the May 10 issue to the March 29 issue, I see that, yes, there are more pages, but not all that many when you factor out the extra full-page advertising and gratuitous full-page artwork. Overall, I could live with smaller pictures and more content. I am not entranced by the easy-to-read format with sidebars reminiscent of high school textbooks. Unfortunately you are still the best read on the block, so I continue my subscription in hopes I can adapt to this brave new world. ERIC W. GREENE, BINGEN, WASH.

Editor, Science News 1719 N Street, NW, Washington, D.C. 20036 or editors@sciencenews.org All letters subject to editing.

Send communications to:

# Einstein and Oppenheimer: The Meaning of Genius

Silvan S. Schweber

n mid-20th century America, two scientists towered over all others in the public mind: Albert Einstein and Robert Oppenheimer. Oppenheimer was the man who built the atomic bomb; Einstein's theories explained how such a vast release of energy was possible. Both were acclaimed as geniuses of the highest order. Yet they were dissimilar in numerous respects. Einstein was solitary, kind, self-assured and even stub-



born; Oppenheimer was gregarious, witty, sometimes sarcastic and cruel, and at some level deeply insecure. Historian Silvan

S. Schweber exploits these contrasts to

explore the meaning of genius, especially with respect to how these two geniuses interacted with a non-scientific society. Many previous writers have examined both men's lives thoroughly, but Schweber brings fresh insight by focusing on less widely noted episodes. Aspects of Einstein's personality emerge more clearly, for example, in the accounts of his role in the founding of Brandeis University. Oppenheimer's inner thoughts surface through analysis of a series of lectures he delivered at Harvard.

Schweber observes that Einstein exuded a constant sense of self and self-assurance throughout his life. Oppenheimer remade himself several times as his role evolved from student, to teacher, to lab administrator and then public figure.

The differences in their personalities played out in their engagement in world affairs. After World War II, both attempted, each in his own way, to influence politicians to forge international controls over the new atomic weaponry, and both failed. Genius—no matter what kind—and politics, it seems, don't mix. Schweber's story shows the difficulties that geniuses encounter in realms where knowledge and logic are not valued as much as power and profit.

#### —Tom Siegfried

Harvard Univ. Press, 2008, 432 p., \$29.95.

# Naked in the Woods: Joseph Knowles and the Legacy of Frontier Fakery

Jim Motavalli

ast summer, the Discovery Channel temporarily suspended airing its hit survivalist show *Man vs. Wild.* The producer admitted that the protagonist would get help from staff or spend nights in hotels—all along claiming to rough it alone in the world's most inhospitable places. Yet, *Man vs. Wild* was not the first high-profile case of possible "frontier fakery."

In August 1913, Joseph Knowles, a former *Boston Post* illustrator, one-time trapper, hunting guide and Navy man, went into the Maine woods on a solitary retreat. Starting out with nothing, not even clothes, Knowles thrived for two months by catching fish, gathering roots and berries, and killing game, the *Post* recounted in frequent updates. Knowles' feat was touted as a "scientific experiment" to demonstrate that humans could still make it when deprived of the conveniences of modern life. He was a short-lived media sensation.

But soon after Knowles' triumphant return to Boston, another newspaper printed an exposé: Knowles had received help all along. He had spent time drinking beer at a lodge. And the bear skin he sported during many public appearances hosted bullet holes.

Motavalli enriches the narration with historical context. But perhaps more



important, Motavalli explores the enduring significance of the wilderness in American culture. —Davide Castelvecchi

Da Capo Press, 2008, 352 p., \$26.95.

# Human Origins: What Bones and Genomes Tell Us about Ourselves



history and how we understand it. Texas A&M Univ. Press, 2008, 216 p., \$29.95.

# Global Fever: How to Treat Climate Change

William H. Calvin An opening image of Edvard Munch's "The Scream" will have you flipping quickly to "Turning Around by 2020." Univ. of Chicago Press, 2008, 337 p., \$22.50.

# Guilty Robots, Happy Dogs: The Question of Alien Minds

David McFarland The alien minds are of animals. The question: Can robots mimic them? Oxford Univ. Press, 2008, 252 p., \$34.95.

# Finding Home

Sandra Markle and Alan Marks For young readers, the story of a koala who survived a brush fire.



HUMAN

ΕV

GUILTY

**HEINS** 

Charlesbridge, 2008, 16 p., \$15.95.

# Trees, Truffles, and Beasts: How Forests Function

Chris Maser, Andrew W. Claridge and James M. Trappe An argument that simple policies will not save complex forests.

Rutgers Univ. Press, 2008, 280 p., \$26.95 (paperback).

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 the Amazon.com bookstore. Sales generated through these links contribute to Society for Science & the Public's programs to build interest in and understanding of science.



# Steven Hyman

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

# U.S. science policy needs to heed global realities

have just returned from Singapore and Shanghai, where I visited life science research sites at universities, hospitals, pharmaceutical companies and Singapore's Biopolis. These institutions, and the government support behind them, invite complex reflections on the situation in the United States.

The United States is home to academic, commercial and government research institutions that remain the envy of the world. The total U.S. investment in research is very large compared with other countries. For example, the National Institutes of Health budget exceeds \$29 billion; the National Science Foundation budget is more than \$6 billion. Moreover, the United States has a strong tradition of philanthropy for biomedical research by universities and hospitals, and a venture capital community that helps move research into the commercial arena.

In addition, U.S.–based life science– related industries have very large investments in research and development. U.S. universities and hospitals are among world leaders in papers, citations and patents. In aggregate, the United States has the greatest laboratory infrastructure and intellectual critical mass in the sciences and engineering in the world.

Why then a feeling of disquiet on returning home?

A major difference between the United States and Singapore and China is the rapid growth rates in these countries, inspiring optimism. In all Singapore's science sectors, and especially Shanghai's industrial sector, there is a palpable sense that infrastructure and funding will be available, and that what is limiting are talented people and ideas. Such people are being actively recruited as governments attempt to build modern knowledge-based economies.

A marker of the sense of scientific opportunity in Singapore and China is the migration of mid-career scientists from the United States, England and Australia to Singapore, and the return of talented Chinese scientists who had been educated in the United States to permanent research positions in China. Their return resulted from the perception of greater opportunity.

In *The World is Flat*, Thomas L. Friedman describes globalization based

in part on the growing ability of information and capital to move freely across the world. Human beings seeking opportunity are clearly not as free to move about the globe as money seeking investments. Humans are sticky. They are connected to communities; they may have working spouses and children well ensconced in schools. Still, many scientists will uproot themselves based on the availability of infrastructure, intellectual communities, funding and freedom to do the work for which they were trained. Singapore and China provide these ingredients to attract talented individuals.

I am an internationalist; I very much want to see science thrive wherever it may and for its benefits to be spread to all populations. At the same time, I live in the United States and am concerned about our ability to generate knowledge, new treatments and good jobs in a "flat" world that appreciates the advantages created by the conjunction of universities, hospitals and industry with a growing research infrastructure.

Is the problem for the United States simply that its scientific and engineering research enterprises are large and mature, making growth and change difficult? From my vantage, having directed an NIH institute (NIMH, 1996–2001) and now serving as provost of a large research university, I do not believe that the U.S. scientific enterprise has reached an asymptote — rather that it is suffering from shortsighted public policy. In recent years a relatively flat NIH budget has lost buying power against inflation. It remains difficult for graduate students



I do not believe that the U.S. scientific enterprise has reached an asymptote rather that it is suffereing from shortsighted public policy. and scientists from abroad to obtain visas to study or work in the United States. Limits on federal funding of stem cell research represent high financial and administrative hurdles to a promising avenue of discovery, and create just the sort of barrier that causes important research to move offshore.

Of course, the federal budget deficit is deep, and the country has many claims on its tax revenues. No one doubts the need for security measures at the border, and my concerns about limits on stem cell research are not a call for an ethical free-for-all. That said, it is much to

be hoped that the next president of the United States will recognize the benefits of a healthy scientific enterprise. Ideally the new administration will craft policies to produce steady growth in federal research budgets, more welcoming immigration policies for foreign scientists and respect for science. Without such policies, many of our most talented students will gravitate to endeavors other than science, and Americans will increasingly read of breakthroughs coming from other shores.

Steven Hyman is provost at Harvard University and former director of the National Institute of Mental Health.

# World's Most Valuable Timepiece Disappears

**B** ack in 1933, the single most important watch ever built was engineered for a quiet millionaire collector named Henry Graves. It took over three years and the most advanced horological technique to create the multifunction masterpiece. This one-of-a-kind watch was to become the most coveted piece in the collection of the Museum of Time near Chicago. Recently this ultra-rare innovation was auctioned off for the record price of \$11,030,000 by Sotheby's to a secretive anonymous collector. Now the watch is locked away in a private vault in an unknown location.

We believe that a classic like this should be available to true watch aficionados, so Stauer replicated the exact Graves design in the limited edition Graves '33.

The antique enameled face and Bruguet hands are true to the original. But the real beauty of this watch is on the inside. We replicated an extremely complicated automatic movement with 27 jewels and seven hands. There are over 210 individual parts that

27 jewels and 210

band-assembled

parts drive this

classic masterpiece.

are assembled entirely by hand and then tested for over 15 days on Swiss calibrators to ensure accuracy. The watches are then reinspected in the United States upon their arrival.

#### What makes rare watches rare?

B MAD

OC SEP OC

Business Week states it best..."It's the complications that can have the biggest impact on price." (Business Week, July, 2003). The four interior complications on our Graves<sup>™</sup> watch display the month, day, date and the 24 hour clock graphically depicts the sun and the moon. The innovative engine for this timepiece is powered by the movement of the body as the automatic

> rotor winds the mainspring. It never needs batteries and never needs to be manually wound. The precision crafted gears are "lubricated" by 27 rubies that give the hands a smooth sweeping movement. And the watch is tough enough to stay water resistant to 5 atmospheres. The movement is covered by a 2-year warranty.

Not only have we emulated this stunning watch of the 1930s but just as surprising, we've been able to build this luxury timepiece for a spectacular price. Many fine 27-jewel automatics that are on the market today are usually priced well over \$2,000 dollars, but you can enter the rarified world of fine watch collecting for under \$100. You can now wear a millionaire's watch but still keep your millions in your



The face of the original 1930's Graves timepiece from the Museum of Time.

vest pocket. Try the handsome Graves '33 timepiece risk free for 30 days. If you are not thrilled with the quality and rare design, please send it back for a full refund of the purchase price.

# Not Available in Stores

Call now to take advantage of this limited offer.

Stauer Graves™ 33 Wristwatch <u>or</u> 3 credit card payments of \$33 +5&H 800-859-1736

Promotional Code GRV857-04 Please mention this code when you call.

To order by mail, please call for details.



14101 Southcross Drive W., Dept. GRV857-04 Burnsville, Minnesota 55337

For fastest service, call toll-free 24 hours a day 800-859-1736 ES TO States Service, call toll-free 24 hours a day 800-859-1736 ES TO States States States States and Collectibles States Stat

# **Hear TV Without Annoying Others!**

# Easier listening for everyone

- Watch and listen to TV while your husband or wife sleeps
- Perfect for those with slight, medium or extreme hearing difficulties
- · Works even when TV volume is totally off
- · Kids play video games without driving you nuts
- Actually works from one room to the next!

# No more shouts of "Turn the TV down!"

There isn't a family we know that hasn't had a conflict over the volume of their TV. Too loud for mom, not loud enough for grandpa, never loud enough for the kids. Now you can listen to TV at your ideal personal volume with the help of the Bell+Howell® TV Headset, utilizing innovative sound enhancement.

# Clears up sound, sweeps away noise

The Bell+Howell® TV Headset is no ordinary headset. It amplifies volume, but more importantly, it helps those with hearing loss by transferring hard to distinguish sounds and voices clearly. Other cheap amplifiers amplify ALL the sounds so you can't hear the words clearly against all the background noise. The Bell+Howell® TV Headset keeps the background noise in the back where it belongs. In addition, sound is adjustable for each ear separately through volume balance control, so you can customize to your listening needs.

# Light as a feather comfort

Remember those old fashioned wireless earphones? So bulky and heavy we all looked like helicopter pilots? Replace them with the TV Headset, which weighs a mere 2 ounces. It fits under the chin for the ultimate in comfort- it won't even mess up your hair. The TV Headset is so lightweight you'll barely notice they're on.

# **Everyone loves this headset**

"My wife doesn't complain the TV is too loud anymore"

"We use them at the movies too!"

"My kids are playing video games without blasting the rest of us out of the room."

"It's like having a set of new ears!"

"Grandma refuses to use her hearing aids, but she loves her headset."

# Freedom to move about - Totally wireless

Forget annoying leash-like wires. The wireless TV Headset uses safe wireless technology to transmit crystal clear sound from your TV to your headset for a HUGE 7800 square foot area! You can move from one room to the next and even go outside to check the BBQ without missing the ballgame!

# Bell & Howell Performance - 100th Anniversary

Bell+Howell, a leader in providing cutting edge products and technology, is celebrating it's 100th Anniversary! The advanced Bell+Howell TV Headset features the expertise and quality that you expect from the established well respected 100 year Bell+Howell name.

# How can we offer this state-of-the-art headset at such a price?

We have a special arrangement to offer you the Bell+Howell® TV Headset at a fraction of the price of other wireless headsets (due to high volume capabilities). But at this price, we expect our inventory to sell out fast! Ask for special pricing when you buy additional headsets. And we are so sure that you will love this headset that you get a 30-day, 100% money back product guarantee. WARRANTEED. NOT AVAILABLE IN STORES.



# LOADED WITH FEATURES:

- Bell+Howell performance
- Safe wireless technology
- Amplifies TV volume and not background sounds
- Hear hard to hear words & voices for crystal clear listening
- Light weight (about 2 ounces)
- HUGE wireless range (over 7800 square feet!)
- · Actually works from one room to the next
- Left / right ear volume balance control for customized listening
- Quick charge for hours of listening
- Rechargeable batteries included



# www.stvheadset.com



Base can charge 2 headsets at the same time