SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

NOVEMBER 3, 2007 PAGES 273-288 VOL. 172, NO. 18

evolution convolution

hiv jumped from haiti in '69

clues to newt's new limbs

martian equator on ice?

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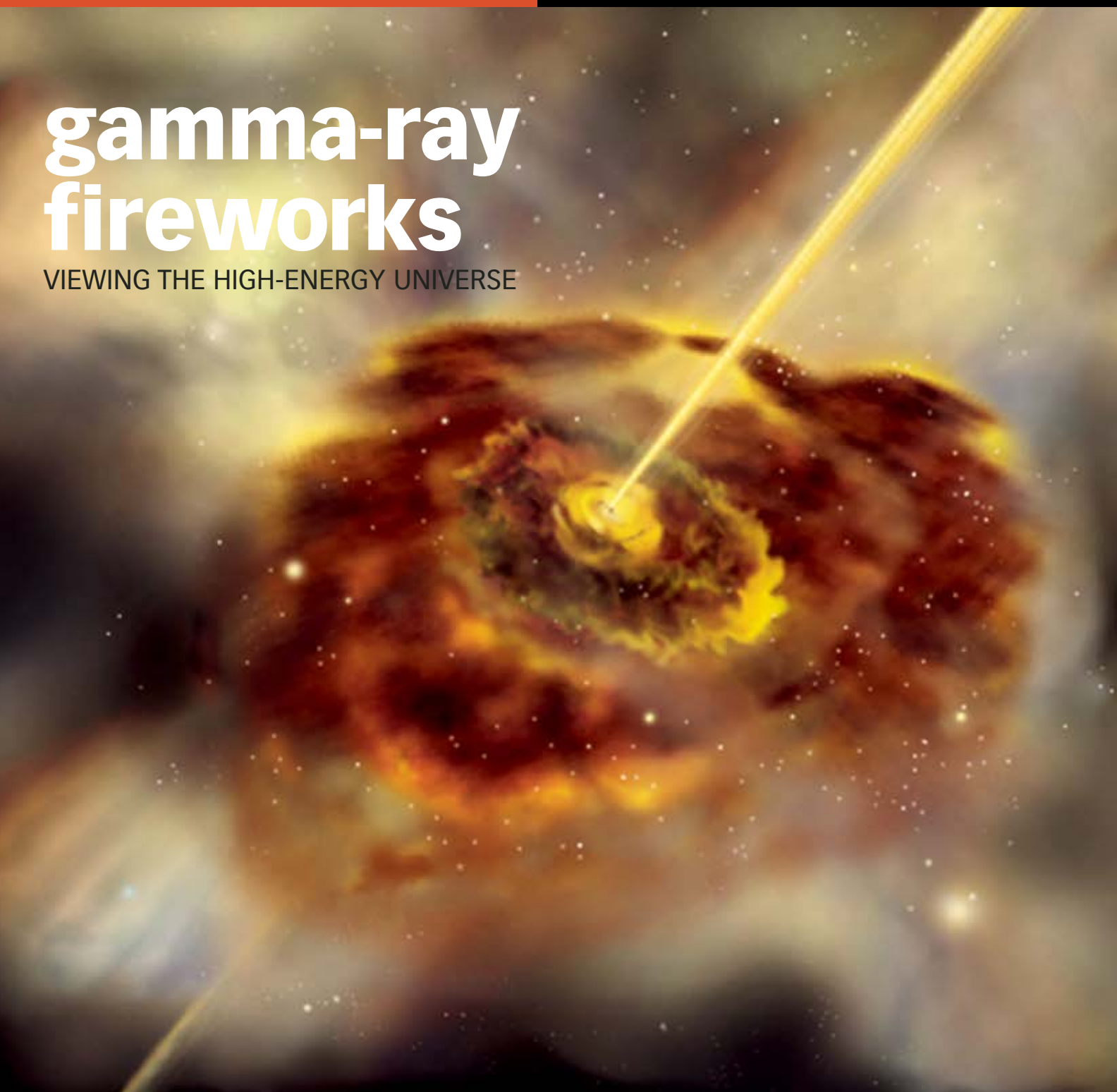

gamma-ray fireworks

VIEWING THE HIGH-ENERGY UNIVERSE

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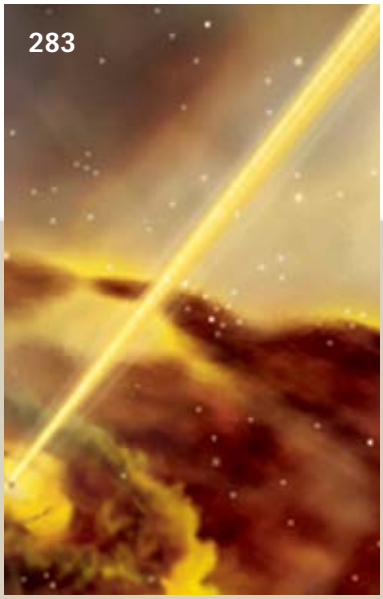

Features

This Week

THIS WEEK ONLINE
http://blog.sciencenews.org/

MathTrek A supercomputer model fed by real-time data is beginning to make sense of the seemingly unpredictable movement of wildfires.

Of Note

Meetings

Departments

Cover NASA's Gamma-Ray Large Area Space Telescope, set for launch next spring, will view violent cosmic events such as jets of gamma-ray–emitting material shot out of monster black holes at the centers of galaxies, as illustrated here. (A. Simonnet/Sonoma State, NASA)
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Early Arrival

HIV came from Haiti to United States

An analysis of 25-year-old blood samples pushes the arrival of HIV in the United States back to about 1969, 12 years before AIDS was first described by a doctor in Los Angeles. The virus came from Haiti, which served as a Western Hemisphere toehold for the early stages of the epidemic starting in the mid-1960s, according to the analysis.

"There have been some suggestions that the virus may have been [in the United States] before the mid-1970s," says Michael Worobey, a microbiologist at the University of Arizona in Tucson, who led the study. "But there's also been lots of skepticism." He says that his research provides the first "rigorous" evidence of an earlier U.S. arrival of HIV.

"I'm convinced," says Beatrice Hahn, a microbiologist at the University of Alabama School of Medicine in Birmingham. "It's a very nice piece of work that accounts for all the variables."

The new study fills in a crucial segment of the HIV time line. Earlier research by Hahn and others pointed to 1930 as the date when HIV jumped from West African chimpanzees into people, likely via hunters who butchered the apes. An unrecognized outbreak percolated in Africa for decades before jumping to Haiti, according to that research.

There, the virus evolved into several variants. Most were dead-ends, causing few infections. But the new study, which appears online and in an upcoming *Proceedings of the National Academy of Sciences*, shows that a variant dubbed subtype B jumped from Haiti to the United States before igniting the current pandemic.

Worobey and his team reached their conclusions by listening to the ticking of HIV's "molecular clock"—the rate at which the virus accumulates genetic mutations. The pattern of these mutations tells researchers on which branch of an evolutionary tree to place individual viruses. The molecular clock allows the scientists to peer into the past to see when the branches split from a common ancestor.

Over the past several years, researchers have improved their clock-watching skills by building a database of HIV samples from around the world. Worobey tapped into this database to examine the genetics of 109 subtype B viruses.

He then added data from five Haitian AIDS patients treated in Miami in the early 1980s, before HIV had been identified as the cause of the disease. Arthur Pitchenik, the pulmonologist who treated the patients, sensed an important trend and sent blood samples to the Centers for Disease Control and Prevention in Atlanta. "It was a no-brainer to freeze the blood for further study," he says.

From those samples, Worobey fished out DNA made by the Haitians' HIV. This evidence added several branches to the existing HIV evolutionary tree and proved that the virus arrived in the United States from Haiti in 1969, give or take a few years, says Worobey. —B. VASTAG

Cousin Who?

Gliding mammals may be primates' nearest kin

Hey, primates, meet the colugos—two little-known species of small rain forest mammals now presented as your next of kin.

With one species native to the Philippines and the other to Southeast Asia, colugos can stretch out a membrane that lets them leap off trees and glide some 70 meters.

They've landed on the nearest surviving evolutionary branch to primates', suggests a new genetic analysis by William Murphy of Texas A&M University in College Station and his colleagues. The researchers added a novel twist by looking at rare genetic glitches as well as familiar genes.

"Having the closest relative really allows us to understand the change of events that led to primates," says Murphy. That in turn feeds efforts "to better understand the changes that make us human."

The dawn of primates has been hard to figure out, Murphy says, because big lineages have split and resplit so fast, from an evolutionary standpoint, that branches had little time to accumulate telltale differences before splintering further. Recent research suggests that tree shrews, colugos, and primates descended from a common ancestor, but scientists have not been able to agree on the order in which these branches diverged.

Murphy and his colleagues have now searched 36 animal genomes for rare glitches called indels, short stretches of DNA that appear in some genomes and are absent from others. Murphy points out that it's unlikely for an indel to have occurred independently in exactly the same place in two species.

The researchers found seven indels shared by colugos and primates but not seen in the other mammals. They found only one indel that's shared by just tree

N. LIM/NATIONAL UNIV. SINGAPORE

NEARLY PRIMATE Possibly one of the two living species closest to primates, a Malaysian colugo mother shelters a youngster. A colugo leaping off a tree (inset) snaps open a membrane for prodigious gliding powers.

shrews and primates. That pattern supports the notion that the tree shrew lineage branched away first, leaving colugos as our nearest cousins, Murphy and his colleagues conclude in the Nov. 2 *Science*.

The team also created a more traditional family tree, based on DNA sequences from a range of mammals, which showed the same pattern.

"In short, yes, I buy it," says Anne Yoder, who directs the Duke Lemur Center in Durham, N.C. She says that she'd like to see more species included in the analysis but calls the methodology "quite sound."

Morphologists sound less enthusiastic. Jonathan Bloch of the Florida Museum of Natural History in Gainesville and Mary Silcox of the University of Winnipeg in Manitoba say that they agree with Murphy's arrangement of fossils but are not completely convinced by his placements of living species.

Eric Sargis of Yale University says that some 30 evolutionists are collaborating on the biggest study yet of mammal relationships, which may overwhelm all previous research. —S. MILIUS

Extreme Healing

Protein aids limb regrowth in newts

Chop off the leg of a salamander or newt, and the limb will slowly grow back. How the wounded stump regrows into a leg is poorly understood, but now researchers have identified a key protein behind this regenerative power.

Studying animals with such regenerative abilities might reveal ways to induce feats of radical self-healing in people, some scientists believe.

When a newt's leg is severed, muscle cells at the site of injury revert to a less-specialized state, becoming stem cells. These stem cells then divide and grow to regenerate the limb.

Jeremy P. Brockes of University College London and his colleagues found that a protein called newt anterior gradient (nAG) is essential to the regeneration process. The researchers were trying to answer an intriguing question: If a newt's leg is severed at the ankle, the stem cells will regrow a foot. When the leg is cut off at its base, however, identical stem cells will grow an entire leg. But how does the mound of stem cells know where it is?

"That's a very profound question," Brockes says. His team already knew that a compound in newts known as Prod 1 can provide a road map for cell regrowth. From the base of the animal's leg to its foot, the concentration of Prod-1 slopes gradually from high to low. Searching for proteins that can bind to this marker compound, the scientists identified nAG, which is similar to a protein that helps guide brain development in vertebrates.

LIKE NEWT When the leg of a newt is severed near the ankle, only the foot regrows (left sequence, top to bottom). When the entire leg is severed, stem cells know to regrow the whole leg (right sequence).

Although this finding alone didn't tell the researchers how the stem cells would know where they are, they soon realized that nAG explains a different curiosity about limb regeneration. Newt embryos begin forming legs when the stubs have not yet developed nerves, but an adult newt's leg will regrow only if the nerve running through it also regrows. If the nerve fails to grow for some reason, the stem cells at the wound won't multiply. Scientists have been trying to explain why since the 1950s.

The nerve's insulating sheath releases nAG, probably in response to chemical signals from the nerve, Brockes suggests. Even when the researchers blocked the nerve and sheath from regrowing, adding nAG to the stem cells was sufficient to cause the cells to resume dividing and to fully regenerate the limb, the researchers report in the Nov. 2 *Science*.

"Lo and behold, that's all that you need to make the cells divide," comments David Stocum, who studies limb regeneration at Indiana University-Purdue University Indianapolis. "That is truly impressive."

Proteins similar to nAG exist in people and other mammals, but further research is needed to show whether mammalian cells have latent potential for such extreme regeneration. —P. BARRY

Clay That Kills

Ground yields antibacterial agents

A fistful of slimy green clay may be just what the doctor ordered. Researchers studying a special type of French clay found that it smothers a diverse array of bacteria, including antibiotic-resistant strains and a particularly nasty pathogen that causes skin ulcers in some parts of the world.

Anecdotal accounts of clay's medicinal value, particularly in cleansing and protecting the skin, date back millennia, says geochemist Lynda Williams of Arizona State University in Tempe. In 2002, Williams was approached by a French humanitarian who had been using the special clay to treat Buruli ulcer, a disfiguring illness caused by *Mycobacterium ulcerans*. This ailment leads to many amputations in Central and Western Africa.

After seeing the clinical data on the clay's effectiveness against Buruli ulcer, Williams established a multicenter, interdisciplinary team of researchers to study the clay.

The researchers found that the clay, which they refer to as CsAg02, is strongly alkaline, with pH ranging from 9.4 to 10. It's also rich in a chemical form of iron that gives it a characteristic green color. But many other clays have similar properties, says Williams.

To assess the effects of the clay on different microbes, the scientists incubated a variety of bacterial cultures with either CsAg02 or a similar clay. CsAg02 completely stopped the growth of *Escherichia coli* and *Salmonella typhimurium*, common causes of food poisoning, and of various strains of mycobacterium that lead to skin infections and ulcers.

In addition, CsAg02 inhibited the growth of both normal and antibiotic-resistant strains of *Staphylococcus aureus*, the most common cause of staph infections. The other clay enhanced the growth of some bacteria and had no effect on others. The researchers presented their findings in Denver on Oct. 29 at the annual meeting of the Geological Society of America.

To get at the root of how CsAg02 kills bacteria, the researchers treated the clay with a concentrated salt of potassium, which draws out charged molecules. This blocked the antibacterial function of the clay, suggesting that one or more of these charged molecules may normally disrupt bacterial metabolism. Williams has planned further studies to nail down what minerals in particular supply the crucial

molecules. She says that the clay's alkalinity may well be crucial to making the minerals toxic to bacteria. At a neutral pH of 7, the mineral concentrations found in CsAg02 would not be toxic, but the high pH may change that, she says.

Ulli Limpitlaw of the University of Northern Colorado in Greeley says that understanding how clays kill the potent bacteria is a big step in fighting bacterial infections that have no known cures.

"The ramifications of finding something this new and this powerful against some of the microbes they are looking at are huge," she says. "It could really change medicine on some level."

Researchers working with Williams intend not only to encourage the use of CsAg02 itself as a remedy but to promote use of the clay minerals in sewage treatment and as antibacterial agents in air filters. —S. WILLIAMS

Chilled Out?

Ice could lurk beneath Martian equator

Radar observations from a craft orbiting Mars hint that an immense volume of ice-rich material may underlie a vast region along the Red Planet's equator.

The long, narrow, and disconnected swaths of the Medusae Fossae formation extend about 5,400 kilometers along Mars' equator, about a quarter of the way around the planet. This undulating landscape occupies the boundary between the cratered highlands of the planet's southern hemisphere and the lowland plains of the north, says Thomas R. Watters, a planetary scientist at the Smithsonian Institution in Washington, D.C.

Much of the formation's terrain is covered with wind-sculpted hills called yardangs, a sign that the exposed material erodes easily, says Watters. While some scientists have proposed that the Medusae Fossae sediments are composed of volcanic ash, others have suggested that they are ancient accumulations of windblown dust. In any case, Watters says, many researchers have supposed that the overall shape of the terrain follows that of the underlying bedrock.

Radar data collected by the European Space Agency's Mars Express orbiter between March 2006 and April 2007 indicate otherwise, however. Some of the radar waves penetrated surface sediments and bounced back to reveal the underlying bedrock, says Watters. It turns out that the sediments of the Medusae Fossae formation, which in some places reach depths of more than 2 km, sit atop a flat, featureless surface that's probably a continuation of the volcanic plains to the north.

The delay between radar echoes from the surface and from the bedrock provides clues about the properties of the formation's material as well as its thickness, Watters and his colleagues report online and in an upcoming *Science*. Their analyses suggest either that the material is as much as 85 percent ice or that it is ice-poor and has an unexpectedly low density.

If low-density material made up the thickest sections of sediment, its lowermost layers would become compressed, says Watters, and the radar data show no sign of that happening.

The Medusae Fossae formation probably contains about 1.6 million cubic kilometers of material, similar to the volume of the layered deposits in the ice cap around Mar's southern pole, says Watters.

Observations from other Mars-orbiting instruments have hinted at the presence of water elsewhere on the planet, but not in the Medusae Fossae formation (*SN: 6/8/02, p. 355*). However, the hydrogen-detecting sensors used for those observations could detect water only if it appeared within 1 meter or so of the surface, says William V. Boynton, a geochemist at the University of Arizona in Tucson.

Current models of Martian climate suggest that buried ice can't persist in equatorial regions, says Jim Bell, a planetary scientist at Cornell University. "Scientists likely will be naturally and reasonably skeptical of the new findings," he notes, but adds that "if the new results are correct, they're unexpected and exciting; there's nothing that says Mars can't be perverse." —S. PERKINS

Stimulant Inaction

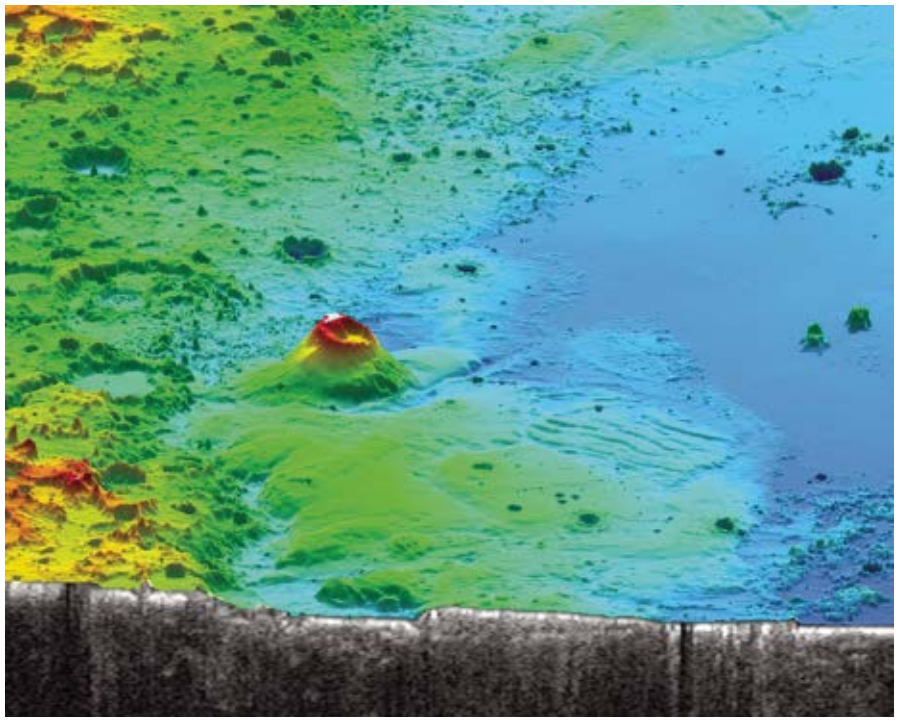
ADHD drug's mental lift proves surprisingly weak

Children with attention-deficit hyperactivity disorder (ADHD) often calm down and behave better when taking the stimulant medication methylphenidate. Nonetheless, this drug largely fails to alleviate underlying mental difficulties considered crucial to ADHD, a new study finds.

Methylphenidate, better known as Ritalin, leaves intact a shortage of "executive" mental functions that many researchers suspect elicit ADHD-related behavior problems, say psychiatrist David R. Coghill of the University of Dundee, Scotland, and his colleagues. Executive-functioning tests focus on the ability to ignore distracting information, manipulate information in one's head, and shift attention from one attribute of an object to another.

"Even following clinical improvement with methylphenidate, there remain unaffected [neuropsychological] deficits," Coghill says.

In contrast, the researchers hold, stimulant treatment aids performance on a few basic memory tasks, such as tests of the ability to recognize a previously presented abstract pattern in a set of choices or to remember spatial locations of items in a previously observed scene.



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DEEP VIEW Mars' Medusae Fossae formation (much of the green terrain in this color-coded image) may hold more than 1 million cubic kilometers of ice-rich sediment. The gray-tone cross section at bottom depicts the subterranean structure of the sediments, as inferred from radar data.

The new study appears in the Nov. 1 *Biological Psychiatry*.

Coghill's team studied 75 boys, ages 7 to 15, diagnosed with ADHD at an outpatient psychiatric clinic. Participants received three treatments in different orders, each for 1 month: low-dose methylphenidate, high-dose methylphenidate, and placebo pills. Neither the boys nor the researchers knew which treatment a participant was receiving at a given time.

A majority of the youngsters behaved better during one or both of the drug treatments, according to parent and teacher reports.

Yet in testing on a battery of mental abilities before and after each phase of treatment, methylphenidate produced gains only in basic visual memory and in the ability to identify target images while ignoring distracting images. Even on the latter task, a simple probe of executive functioning, boys with ADHD performed as well, before the study, as boys with no psychiatric disorders did.

Stimulant treatment offered no benefits in complex tests of executive function, such as the ability to recall information needed to achieve a goal.

The study "raises questions about the effects of chronic stimulant treatment [on ADHD]," comment psychologist Scott H. Kollins and psychiatrist John S. March, both of Duke University Medical Center in Durham, N.C., in an accompanying editorial.

A related investigation, published in the August *Journal of the American Academy of Child & Adolescent Psychiatry*, suggests that clinical benefits of stimulant treatment diminish over time. Psychiatrist Peter S. Jensen of Columbia University and his coworkers tracked 485 boys and girls with ADHD who received 14 months of intensive treatment with stimulants, behavior therapy, a combination of both, or routine community care.

Children who received medication showed the most improvement in ADHD symptoms. However, their behavioral advantage disappeared 2 years after completion of treatment.

The researchers also found that children with ADHD were taller and heavier than expected for their age before treatment but then showed stimulant-related decreases in growth rate. Three years of stimulant treatment stunted growth by almost 1 inch and by more than 4 pounds, they estimate. —B. BOWER

STATS

210 thousand

ICU deaths attributed to sepsis in the United States each year

Plugging Leaks

Manipulating receptors may impede sepsis

Using synthetic molecules that bind to signaling proteins on blood vessel cells, scientists have discovered a way to subdue sepsis in mice. They report that activating or disabling the proteins affects the course of sepsis and could provide a way to combat this deadly condition.

Sepsis develops when a blood infection triggers a runaway immune reaction. Patients often become listless or unconscious and show a high fever, rapid heartbeat, and falling blood pressure. Internally, blood leaks through their vessel walls, a catastrophic event that swells nearby tissues. Fluid collects in the lungs, and sluggish blood flow starves organs of nourishment.

Despite decades of research, the biology underlying sepsis has never been fully sorted out, says Athan Kuliopulos, a physician and biochemist at the Tufts University School of Medicine in Boston. Since sepsis has resisted numerous attempts at treatment, some scientists suspect that leakage might stem from some peculiarity of the cells lining blood vessels.

In the 1990s, scientists discovered a protein called protease-activated receptor 1 (PAR1) and three sister proteins on blood vessel cells. As a receptor protein, PAR1 signals its cell when bound by a molecule that fits it.

A receptor typically issues a consistent, predictable signal when activated. "We hypothesized that PAR1 might be changing its role" in sepsis, Kuliopulos says.

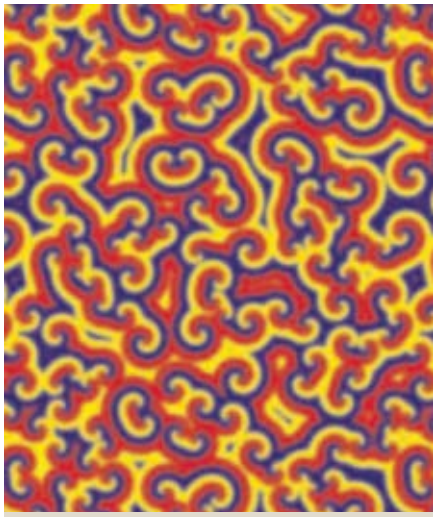
He and his colleagues devised synthetic compounds that bind to the receptor, allowing them to switch it on or off. They then tested the compounds in mice with sepsis. When PAR1 was switched off at the onset of sepsis, 60 percent the mice survived. Among mice given a PAR1 activator at the start, nearly all died.

In mice that had had sepsis for 4 hours, PAR1 indeed seemed to reverse its role. These mice fared better if PAR1 was activated, but succumbed when it was shut down, the researchers report online and in the December *Nature Immunology*. Further tests showed that sepsis caused leakage in blood vessels in the lungs and that manipulation of PAR1 could limit that damage.

Such leakage results when vessel-lining cells detach from one another. In a separate set of experiments, the researchers found that activation of both PAR1 and a sister receptor, PAR2, is necessary for these cells to restore the lining. In mice engineered to lack PAR2, reactivating PAR1 did not cause vessel linings to reassemble.

The new study makes "a reasonable case that in sepsis ... the activation of PAR1 has both damaging effects and protective effects, depending on the circumstances," says pathologist Peter A. Ward of the University of Michigan Medical School in Ann Arbor.

If tests in healthy people show that the antisepsis compounds are safe, Ward says, a second-stage trial might test them in gravely ill patients. But, he cautions that because of PAR1's role-reversal propensity, "it might be very tricky." —N. SEPPA



REICHENBACH

Rock, paper, toxins

In many ecosystems, several competing species coexist because none is best at everything. Tobias Reichenbach of the Ludwig Maximilian University in Munich and his colleagues ran computer simulations of three virtual bacteria species fighting a sort of rock-paper-scissors game. One species produces a toxin. A second is immune to the toxin and outcompetes the first. A third species is sensitive to the toxin but can overtake the second species because it's unburdened by the metabolic cost of producing an antidote. Each virtual population, shown here in a different color, propagates in waves as it pushes aside its weaker competitor while being chased by the stronger one, the researchers explain in an upcoming *Physical Review Letters*. Scientists have observed similar patterns among certain marine organisms. —D. CASTELVECCHI

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Dore Bible Illustrations, Courtesy of Dover Pictorial Archive Series

Moses Coming Down from Mount Sinai by Gustave Dorè

Professor Levine also provides thoughtful reflections and useful information on religious questions that arise from these texts. The goal of an academic course in biblical studies, she maintains, is not to undermine religious faith, but to use the best available knowledge and research to give believers richer insight into the writings that form their spiritual bedrock.

About Your Professor

Professor Amy-Jill Levine (Ph.D., Duke University) is E. Rhodes and Leona B. Carpenter Professor of New Testament Studies at Vanderbilt University Divinity School, where she also holds the position of Director of the Carpenter Program in Religion, Gender, and Sexuality. She is a prodigious scholar, author, and lecturer.

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FOSSIL SPARKS

New finds ignite controversy over ape and human evolution

BY BRUCE BOWER

Fifty years ago, British anatomist Wilfrid Le Gros Clark explained in a lecture why evolutionary scientists argue so vehemently about how ancient apelike and humanlike creatures eventually gave way to modern humans. "Every fossil relic which appears to throw light on connecting links in man's ancestry always has, and always will, arouse controversy," he stated, "and it is right that this should be so, for it is very true that the sparks of controversy often illuminate the way to truth."

Le Gros Clark was no stranger to wringing the truth out of bits of fossilized skeleton. In 1953, he assisted in unmasking the infamous Piltdown hoax. For more than 40 years, researchers had assumed that skull and jaw fragments collected from a British gravel pit came from a previously unknown early human species. The finds actually consisted of an orangutan's lower jaw and a modern man's skull.

But Le Gros Clark knew that genuine fossil discoveries ignite brighter sparks of controversy than any cranial con job ever could. Given limited evidence about long-gone populations of our predecessors, researchers devise competing evolutionary scenarios that are often difficult to disprove and that can easily accommodate whatever ancient bones turn up next.

Scientific reactions to the latest fossil finds and analyses underscore Le Gros Clark's point. Consider a handful of 10-million-year-old teeth recently unearthed in Ethiopia and attributed by their discoverers to a direct ancestor or close relative of the gorilla. If the scientists are right, ancient gorillas initially diverged from human ancestors more than 10 million years ago, several million years before DNA-based analyses date the split. However, some researchers regard the ancient teeth as remnants of an extinct ape that probably bore no relation at all to gorillas.

Further along evolution's path lie new fossil finds in Kenya that tell a disputed story about the emergence of direct human ancestors. Scientists who uncovered the ancient braincase and partial upper jaw say that this evidence, combined with prior fossils, indicates that two *Homo* species lived simultaneously in eastern Africa from about 1.9 million to 1.4 million years ago. In this scenario, one species died out and the other led to modern humans. But one prominent anthropologist rejects that conclusion, placing both new fossils in a single species that preceded *Homo sapiens*.

Finally, a research team recently argued that its new analysis of fossil teeth from sites in and beyond Africa supports the controversial notion that human ancestors trekked from Africa into Asia well before 2 million years ago and then colonized Europe from Asia. Critics of the work say that more fossil evidence is needed to overturn this team's conclusion that Africans migrated into Asia no more than 1.8 million years ago and eventually settled Europe as well.

"It's possible that hominids [the fossil ancestors of people] left Africa as early as 2 million years ago," says anthropologist Tim White of the University of California, Berkeley, "but it's hard to untangle the geographic patterns of their movements."

DENTAL PLAN — Three *Chororapithecus* teeth (left) are shown aligned with the corresponding teeth of a female gorilla.

SUWA

PIECES OF APE In February 2006, a field assistant working with fossil hunters in Ethiopia's Chorora Formation, a series of sediment layers dated at between 10 million and 11 million years old, found an ape's canine tooth. One year later, the researchers returned to the site and found eight more teeth from the same ancient-ape species, which they dubbed *Chororapithecus abyssinicus*.

Anthropologist Gen Suwa of the University of Tokyo and his coworkers see signs of gorilla ancestry in the fossils. Computerized tomography scans show that the gorilla-size teeth contain thick enamel suitable for shredding foods such as stems and leaves, the scientists report in the Aug. 23 *Nature*. Modern gorillas display slightly thinner dental enamel but eat the same types of vegetation. Crests on the chewing surfaces of the ancient teeth look like early versions of the more-pronounced crests in present-day gorillas, the researchers note.

Chororapithecus represents either an early, direct ancestor of gorillas or a dead-end primate that happened to evolve gorilla-like teeth, in their view.

Precious few African-ape fossils from between 12 million and 7 million years ago have been recovered. Some scientists have speculated that the line of ancestral apes from which chimpanzees, gorillas, and people emerged came from Asia and Europe and later spread into Africa. *Chororapithecus* suggests instead that this evolutionary process began in Africa, Suwa's team holds.

Moreover, the new finds indicate that an evolutionary split of direct gorilla ancestors from apelike precursors of people occurred more than 10 million years ago, the investigators say. In contrast, analyses of modern human and ape DNA place that split at about 8 million years ago.

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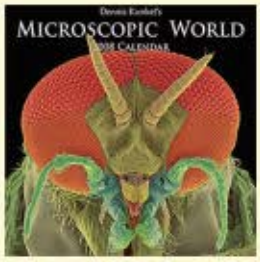

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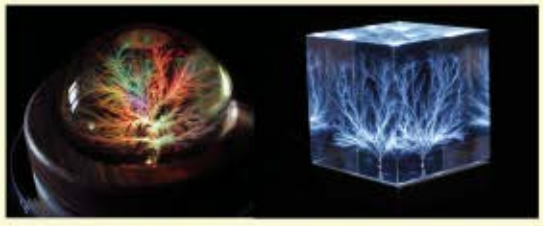

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DNA studies also estimate that the split of chimp from human ancestors happened 6 million years ago, and that the human-orangutan split occurred about 14 million years ago.

Given the age of *Chororapithecus*, Suwa's group puts the human-orangutan split at roughly 20 million years ago, the human-gorilla split at about 12 million years ago, and the human-chimp split at 9 million years ago.

Suwa's conclusion that the Ethiopian fossils come from either a gorilla ancestor or an evolutionary cousin of ancient gorillas makes sense, remarks anthropologist Michel Brunet of the University of Poitiers in France. The teeth of the oldest known hominid, which lived about 7 million years ago, look "completely different" from those of *Chororapithecus*, Brunet says.

The French researcher's team unearthed the ancient hominid's nearly complete skull in central Africa (*SN: 7/13/02, p. 19*). Many investigators accept that specimen as the oldest fossil ancestor of people, but others regard it as an ancient ape.

Chororapithecus also has a disputed identity. The new find could easily have come from an ancient ape that had nothing to do with gorilla ancestors but evolved one or a few gorillalike dental traits on its own, says anatomist John Kelley of the University of Illinois at Chicago. The Ethiopian fossils have virtually nothing in common with the teeth of modern gorillas, aside from crests on their chewing surfaces that would have aided in grinding up vegetation, Kelley asserts.

Suwa will keep looking for more pieces of ape. "There is no way to predict future finds at Chorora," he says.

SHRUNKEN HEAD? — A small, newly discovered *Homo erectus* cranium, shown from above, contrasts with a large, previously unearthed skull from the same species.

SEPARATE PATHS Scientists have long regarded *Homo habilis* and *Homo erectus* as the first two links in an evolutionary chain that ended with the appearance of modern humans. In this view, the relatively small-brained *H. habilis* evolved about 2 million years ago from earlier African hominids. It evolved into the larger-brained *H. erectus* by around 1.6 million years ago.

New fossil finds challenge that portrait of our distant ancestors, say anatomist Fred Spoor of University College London and his coworkers. *H. habilis* and *H. erectus* evolved independently of each other, Spoor's team contends. Rather than one species giving way to the next, both species lived simultaneously in eastern Africa for roughly 500,000 years, the scientists report in the Aug. 19 *Nature*.

That conclusion rests on an analysis of two fossils unearthed in Kenya in 2000. One fossil consists of a piece of upper jaw. Chemical studies of volcanic-ash layers above and below the find place its age at 1.44 million years.

The jaw contains six teeth, running from a canine tooth in front to a wisdom tooth in back. The size and shape of the teeth, as well as evidence that the roof of the mouth was wide and shallow, align the fossil with *H. habilis*, according to Spoor's group.

The second fossil consists of a small braincase with an estimated age of 1.55 million years. This specimen bears several traits unique to *H. erectus*, including a bony ridge running over the top of the head and a delicate jaw joint.

Since the two species coexisted in the same region for such a long time, each must have had separate origins between 3 million and 2 million years ago, the researchers contend. Few hominid fossils have turned up from that period.

H. sapiens apparently evolved from *H. erectus*, possibly via an intermediate species, in Spoor's view. *H. habilis* was a sister species of *H. erectus* and eventually hit an evolutionary dead-end.

The newly discovered fossil brain case belonged to the smallest known *H. erectus* individual. The find thus indicates a size range for *H. erectus* fossils of eastern Africa that almost equals that for modern gorillas. The gorilla pattern reflects males' large size advantage over females, a condition that may also have applied to male and female *H. erectus*, says study coauthor Susan C. Antón of New York University.

If so, then *H. erectus* males may have mated with multiple females and tried to monopolize access to them, as male gorillas do.

Such conclusions don't sit well with Berkeley's White. He classifies both new fossil finds as *H. erectus* and as valuable additions to the fossil record, but hardly the stuff of major evolutionary revisions.

White sees Spoor's paper as part of an ongoing scientific movement to increase the number of species and evolutionary branches on the hominid family tree. In contrast, White argues that early hominids usually evolved from one species to the next, without branching into multiple species (*SN: 4/15/06, p. 227*).

"What's interesting is how few hominid lineages there were," White says. He regards early hominids, or australopithecines, as one such lineage that evolved into a second, the *Homo* lineage, more than 2 million years ago. A group of species called robust australopithecines, which died out 1.2 million years ago, qualifies as a third hominid lineage, in his view.

EASTERN ORIGINS Teeth sometimes tell contested evolutionary tales. That adage applies to a new analysis of hominid teeth conducted by researchers who have found 400,000-year-old skeletons of Neandertal ancestors in Spain and the 1.77-million-year-old remains of an early *Homo* species in central Asia (*SN: 9/22/07, p. 179*). The scientists suspect that, perhaps 2 million to 3 million years ago, Asian hominids began to move west, exerting a huge impact on the evolution of Neandertals and other *Homo* species in western Asia and Europe.

That suggestion contrasts with the traditional view that hominids left Africa around 1.8 million years ago and evolved into species such as Neandertals after reaching Europe and other locales. Asian hominids of the time evolved separately and eventually died out, according to this perspective.

A team led by Maria Martinón-Torres of the National Center of Human Evolution Studies in Burgos, Spain, has examined 51 anatomical traits on more than 5,000 hominid teeth. Fossils came from African australopithecines and from African, Asian, and European *Homo* species, including *H. sapiens*.

Up to the appearance of Neandertals in Europe around 130,000 years ago and modern *H. sapiens* in Africa 200,000 years ago, dental features fall into two geographic categories, the researchers report in the Aug. 14 *Proceedings of the National Academy of Sciences*. African teeth display one suite of characteristics, while Asian and European teeth share a different dental signature.

Asian hominids apparently made a substantial genetic contribution to the evolution of later European species, the scientists say.

However, anthropologist David Frayer of the University of Kansas in Lawrence says that Martinón-Torres and her coworkers need larger numbers of fossils, especially of *H. sapiens*, to make their case. Moreover, the researchers didn't consider several dental traits that differ between Neandertals and Asian hominids, he argues.

To paraphrase Le Gros Clark, let the sparks of controversy fly. They may burn brightly enough to illuminate a bit of evolutionary truth. ■

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GAMMAS FROM HEAVEN

Physicists and astronomers join forces to study the high-energy universe

BY RON COWEN

Not long ago, physicists seeking to understand the cataclysmic events at the birth of the universe had to rely on massive, earthbound experiments in which beams of charged particles, steered by powerful magnetic fields, traveled in circles for miles before smashing into each other. Now, an increasing number of these particle physicists have turned to the skies, teaming with astronomers to launch spacecraft that can capture gamma rays from astrophysical processes with energies far greater than anything that can be generated in the most powerful atom smashers on Earth.

Carrying thousands to billions of times as much energy as visible-light photons, gamma rays "are telling us about the most energetic processes in the universe," says David Thompson of NASA's Goddard Space Flight Center in Greenbelt, Md. But detecting gamma radiation is no easy feat. Scientists have built a variety of ground-based detectors that capture the secondary radiation created when gamma rays crash into gas molecules in Earth's atmosphere, but only a detector above the atmosphere can capture gamma rays directly.

Gamma-ray astronomy got a big boost in 1991 with the launch of the NASA's now-defunct Compton Gamma Ray Observatory (CGRO). That push continued with missions such as the European Space Agency's INTEGRAL satellite and NASA's Swift spacecraft. But the agency's GLAST (Gamma-ray Large Area Space Telescope) mission, set for launch next spring, will give scientists a view of the gamma-ray sky at higher energies and with sharper resolution and greater sensitivity than any previous craft has provided.

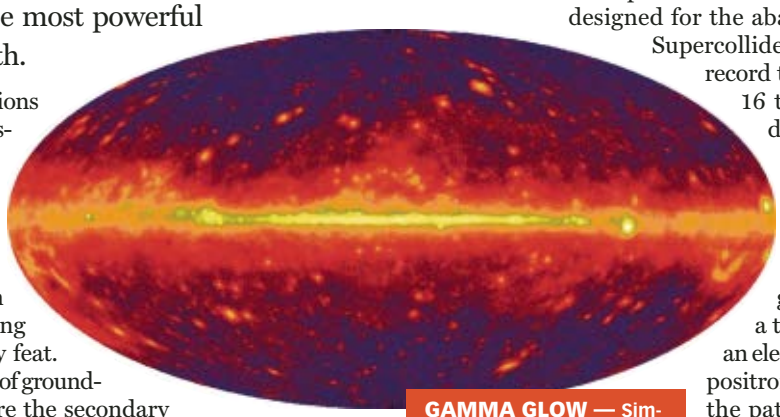
GLAST may shed light on dark matter, primordial black holes, and other cosmic oddities near and dear to the hearts of physicists and cosmologists. The Earth-orbiting craft will detect gamma rays with energies up to 300 gigaelectronvolts (GeV), far beyond the 20 GeV energies that previous instruments in space have reached. "That's a huge discovery window," says GLAST team member Thompson.

RECORDING RAYS Every 3 hours, GLAST's Large Area Telescope (LAT) will scan the entire sky, hunting for sources of gamma rays with energies from 30 million eV (MeV) to 300 GeV. Another suite of 14 separate detectors, the GLAST Burst Monitor (GBM), will cover a vast range of lower energies, from 8,000 eV up to 90 MeV. (Visible-light photons have energies of about 1 eV.) GLAST's goal is reveal the origins of the mysterious and sporadic cosmic flashes known as gamma-ray bursts.

All in all, researchers will have a spacecraft capable of recording gamma-ray radiation over an energy range spanning seven orders of magnitude.

LAT is the modern-day version of the Energetic Gamma-Ray Experiment Telescope (EGRET) instrument, which flew more than a decade ago on CGRO. Because gamma rays are so energetic, they can't be focused or contained using lenses and mirrors as visible light can. EGRET's detectors, relying on a technique originally developed for particle accelerators, were sensitive to energies up to about 20 GeV. EGRET recorded a total of 271 gamma-ray-emitting objects.

LAT uses a more sophisticated version of the same technology, designed for the abandoned Superconducting Supercollider project. It is expected to record thousands of sources. It has 16 tower-shaped gamma-ray detectors, each consisting of thin tungsten foils interleaved with silicon strips, giving a total collecting area of about 35 square meters. An incoming gamma ray that collides with a tungsten atom converts into an electron and its antiparticle, the positron. The silicon strips record the paths of the electron and the positron, from which the arrival direction of the gamma ray can be deduced. The total area of the silicon strips is more than 70 sq m, similar to the area of that in CERN's spanking new Large Hadron Collider, expected to begin operation in Geneva early next year.



GAMMA GLOW — Simulation of the high-energy sky that will be seen by GLAST.

The electron and positron then pass into blocks of cesium iodide, which scintillates as they absorb the energy of each particle. The intensity of the flashes reveals the energy of the electron and positron, and therefore that of their parent gamma ray.

Although gamma-ray images from LAT will be fuzzy compared with the arrestingly sharp visible-light photos that the Hubble Space Telescope produces, they will nevertheless localize the brightest sources to within an area about one five-hundredth the diameter of the full moon. Astronomers expect the images to be the first to reveal structure in what previously appeared as featureless point sources on the gamma-ray sky.

GAMMAS IN THE GALAXY ... At gamma-ray energies, the Milky Way forms a brilliant swath across the sky. Much of this high-energy emission has its origin in supernova remnants, expanding shells of gas created when a blast wave from an exploded star plows into surrounding space, sweeping up material along the way. Intense magnetic fields entrained in these shells of gas can,

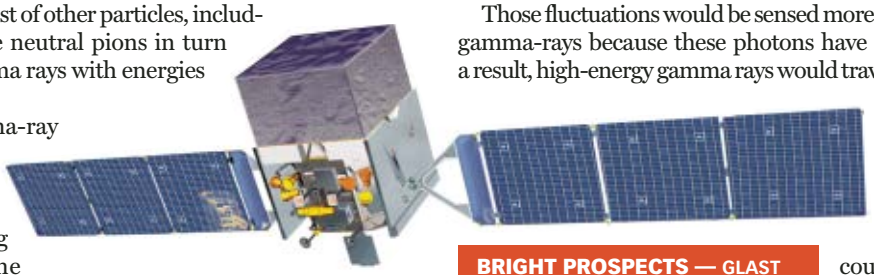
SONOMA STATE, NASA

in theory, boost protons and other charged particles to nearly the speed of light, giving them energies 100 times higher than the most powerful ground-based accelerators can achieve. When these energized protons smash into atoms and molecules in surrounding space, they can spark gamma rays. LAT is expected to detect such sources in unprecedented numbers.

The telescope is also likely to pin down the origin of a significant portion of the spectrum of cosmic rays—charged particles that bombard Earth's upper atmosphere. The highest energy cosmic rays move too fast to be confined to any single galaxy, but their lower-energy cousins are confined by individual galaxies' magnetic fields. Any such particles that strike Earth must therefore have arisen within the Milky Way, and scientists have had strong hints for years that these lower-energy cosmic rays also have their origin in particle acceleration by supernova remnants.

The same fast protons that create gamma rays when they strike atoms will produce a host of other particles, including neutral pions. The neutral pions in turn would decay into gamma rays with energies of around 67 MeV.

Several other gamma-ray telescopes, including EGRE7, have already detected 67-MeV gamma rays coming from the center of the Milky Way. But these craft lacked the spatial resolution and sensitivity to match the radiation with specific supernova remnants. LAT can determine exactly where in the Milky Way the gamma rays are coming from, and so can check whether supernova remnants are indeed the source.



BRIGHT PROSPECTS — GLAST will record gamma rays from exploded stars in our own galaxy to quasars that lie billions of light-years beyond. GLAST will also search for flashes of light that may signal the presence of dark matter.

AND FROM AFAR Looking well beyond the Milky Way, GLAST will examine a subset of active galactic nuclei—galaxies that have supermassive black holes at their hearts, fed by swirling disks of gas. In a process that's still not well understood, jets of gas shoot out of these galactic cores at right angles to the disk, generating a stream of emissions from radio waves to visible light and on up to gamma rays.

Active galactic nuclei whose jets happen to point directly at Earth are especially conspicuous in the sky, and only they produce detectable gamma-ray emission. Known as blazars, they're prime targets for GLAST. "With gamma rays [from blazars], we're looking right down the barrel of the gun of an active galactic nuclei," says Thompson.

Even more puzzling are gamma-ray bursts. Lasting from a few thousandths of a second to several minutes, these cosmic flashes are among the most energetic explosions in the universe. The longer bursts, lasting more than about 2 seconds, are associated with the collapse of massive stars into neutron stars or black holes, while the short-duration ones may be the swan song of two elderly neutron stars about to coalesce. Short or long, a single burst unleashes more energy than the sun will put out during its entire 10-billion-year lifetime, notes GLAST scientist Neil Gehrels of the Goddard Space Flight Center.

The suite of detectors in GBM, GLAST's dedicated burst experiment, looks at the entire sky at once except for a small region blocked by Earth. GBM is expected to find 200 bursts a year, double the average number found by NASA's Swift satellite. Once the GBM locates a burst, it alerts LAT to observe that portion of the sky.

Because Swift has an onboard ultraviolet and visible-light telescope that can home in on bursts, the craft will still be better than GLAST at pinning down precise burst locations. But with its two instruments working in tandem, GLAST will be able to examine bursts up to much higher energies. GLAST will "tell us about the high-energy emission of gamma-ray bursts, way above 1 MeV," notes theorist Andrew MacFadyen of New York University. The 1990s' EGRET experiment revealed a puzzle, he notes: Some bursts emit a large fraction of their energy at energies above 1 GeV and may even emit longer at those high energies than they do at lower energies. If GLAST bears this out, "it would be a significant constraint on both the models and emission mechanism" of bursts, MacFadyen adds.

IT'S ALL RELATIVE GLAST even has a shot at testing a fundamental principle of Einstein's theory of relativity. That theory stipulates that all photons travel through the vacuum of space at exactly the same speed—2.99 x 10^8 meters/second—regardless of their energy.

But Einstein's theory describes gravity only as it operates over large distances. In some proposed models of quantum gravity, which attempt to marry Einstein's theory of gravity to the physics of the subatomic realm, higher-energy photons may travel more slowly than lower-energy ones. In such theories, the vacuum seethes with the constant annihilation and creation of subatomic particles, which in turn create tiny fluctuations in the fabric of space-time.

Those fluctuations would be sensed more acutely by higher-energy gamma-rays because these photons have shorter wavelengths. As a result, high-energy gamma rays would travel a tad more slowly than their lower-energy counterparts.

Because GLAST is sensitive to an extraordinarily broad range of gamma-ray energies, it could look for this effect by examining a galaxy or quasar, billions of light years away, that emits gamma rays over a similarly broad range. Differences in gamma-ray travel speed would mean that a pattern of emission at lower energies would arrive slightly earlier than the corresponding pattern at higher energies.

In searching for such a difference, GLAST would be following up on recent findings from the ground-based MAGIC telescope in Spain's Canary Islands. This telescope records visible-light emissions produced by fast-moving debris generated when atoms in Earth's atmosphere are struck by gamma rays of even higher energy than those GLAST can detect. MAGIC recently examined two flares from the black hole at the center of the galaxy Markarian 501.

For one of the flares, recorded on July 9, 2005, an updated analysis reveals that gamma rays in the range of 1.2 teraelectronvolt (TeV)–10 TeV arrived 4 minutes later than those in the lower energy range of 0.25–0.6 TeV, Jordi Albert of the University of Würzburg in Germany and his colleagues recently reported online (*http://xxx.lanl.gov/abs/0708.2889*). The team can't rule out the possibility that the black hole may simply have emitted the high-energy gamma rays later, however.

INTO THE DARKNESS GLAST may also shed light on dark matter, the invisible material that theorists say accounts for 80 percent of all the mass in the universe and keeps galaxies and galaxy clusters from flying apart. Dark matter is believed to be made of exotic particles unlike those such as electrons and protons that make up ordinary matter.

One such particle has its roots in a theory of elementary particle physics called supersymmetry. Elementary particles are either bosons, which can clump together, or fermions, which cannot. Supersymmetry posits that every particle has a more massive relative, called its superpartner, belonging to the opposite class. For instance, the proposed superpartner of the electron, a fermion, is called the selectron, and would be a boson.

Although superpartners have yet to be observed, theorists have suggested that they might be the building blocks of dark matter.

That's where GLAST enters the picture. Among the supersymmetric candidates for dark matter, the least massive is the grav-

A. SIMONNET/SONOMA STATE, NASA

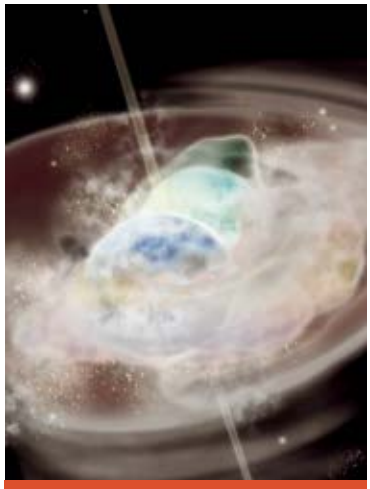
itino, superpartner to the graviton. The graviton, itself hypothetical, is proposed as the quantum particle relating to a gravitational field in the same way as photons relate to electromagnetic field. Gravitinos can decay into photons, including gamma rays, along with other particles that would last longer than the age of the universe. If dark matter consists of gravitinos, their decay would produce a diffuse gamma-ray glow that GLAST might detect, say theorists Alejandro Ibarra and David Tran of the Deutsches Elektronen-Synchrotron facility in Hamburg, Germany, in a paper recently posted online (*http://xxx.lanl.gov/abs/0709.4593*).

GLAST will also search for signs of another group of supersymmetric particles known as weakly interacting massive particles, or WIMPS, that have also been proposed as dark matter candidates. When two WIMPS collide, they annihilate, producing a shower of more-familiar particles, including gamma rays.

It will be tricky for LAT to distinguish gamma rays produced by decaying dark matter from radiation generated by supernovas, hot gas around black holes, and other conventional sources. But the search will be easier if, as theorists suggest, dark matter has a clumpy distribution, so that some parts of the sky will show more-intense gamma emission than others.

In addition, WIMP collisions would generate gamma rays with a specific energy, whereas black holes and supernovas produce gamma rays over a wide energy range, and a cacophony of other radiation besides.

"That's the rosy scenario [but] we might not have a signal that's strong enough to rule out" ordinary astrophysical explanations, cautions GLAST scientist Peter Michelson of Stanford University.



A. SIMONNET/SONOMA STATE, NASA

BINARY BLAST — Merging neutron stars spawn an intense but short-lived burst of gamma rays (diagonal line) in this artist's impression.

Even more speculatively, says Michelson, GLAST might also hunt for signs of evaporating black holes forged in the early universe. Black holes, contrary to popular notion, aren't truly black. Quantum theory, Stephen Hawking showed in 1974, reveals that the boundary between the outside and inside of a black hole is slightly fuzzy. As result, black holes leak radiation into space. The smaller their mass, the more radiation they emit.

Supermassive black holes at the centers of galaxies or starsize ones in the Milky Way are far too massive to emit detectable amounts of Hawking radiation. But if black holes weighing only about a millionth the mass of the sun came into existence soon after the Big Bang, as some theorists have suggested, they would emit significant amounts of radiation, including gamma rays. As they emit energy, the black holes lose mass, which makes them emit even more intensely. This runaway process ends with an abrupt explosion. Some theorists have even suggested that some gamma-ray bursts represent the explosive evaporation of tiny black holes.

Finding a link between gravity and quantum mechanics would be monumental, but the greatest discoveries GLAST will make may be those that aren't anticipated.

"Let us not forget about the unknown," says Thompson. "Despite all our best efforts," he notes, "over half the gamma-ray sources spotted by EGRET remain unidentified. They don't seem to be pulsars, they don't seem to be blazars. They're mysteries to be solved."

GLAST will find thousands of new sources. "We've only scratched the surface," says Thompson, of what the gamma-ray sky may hold. ■

OF NOTE

ANTHROPOLOGY

DNA to Neandertals: Lighten up

Some Neandertals possessed a pigmentation gene in an inactivated form that would have produced pale skin and possibly even red hair, a new study indicates.

A team led by Carles Lalueza-Fox of the University of Barcelona analyzed DNA extracted from two Neandertal fossils, one from Italy and the other from Spain. The researchers scrutinized the *melanocortin 1 receptor* (*MC1R*) gene, variants of which can yield light skin and red hair, especially in people of European descent.

The two Neandertals possessed the same, previously unknown version of the gene, the scientists report in an upcoming *Science*. Studies in cell cultures of the gene variant's protein showed depressed activity consistent with the development of pale skin and red hair, they say.

Investigators have yet to find the Neandertals' *MC1R* gene variant in peoples' DNA. Different inactive versions of the *MC1R* gene evolved in Neandertals and *Homo sapiens*, Lalueza-Fox's group theorizes. —B.B.

MATERIALS SCIENCE

Printing scheme could yield 3-D photonic crystals

Photonic crystals are latticelike structures that can manipulate the flow of light. Materials scientists have now devised a way of making such crystals with complex three-dimensional structures that could serve as the basic elements of optical computers.

The new technique prints 3-D patterns on a surface layer by layer using a specially designed ink. "This allows us to directly write the structures we want," says lead investigator Jennifer Lewis of the University of Illinois at Urbana-Champaign. She and her colleagues describe the process in an upcoming *Advanced Materials*.

The ink consists of an organic chemical containing titanium mixed with a polymer. A 1-micrometer wide nozzle dispenses filaments of ink as it travels over a silicon wafer. The ink dries rapidly, causing the filaments to solidify. Heating at 600° C burns away the polymer and organic material, leaving behind a structure composed almost entirely of polycrystalline titanium dioxide.

The research team used its new technique to make woodpile structures in which layers of 520-nanometer-wide rods are stacked on top of one another, with rods in each layer perpendicular to those immediately beneath. The researchers are also experimenting with transparent and electrically conducting inks that might be useful for printing components in displays and solar cells. —A.G.

Society of Vertebrate Paleontology
Oct. 17-20
Austin, Texas

WHAT'S FOR DINNER?

The first *matrushka*

A team of German paleontologists has unearthed a fossil that preserves one creature inside another that's nestled inside yet another, a Paleozoic version of the Russian nesting dolls known as *matrushkas*.

The unusual find came from material deposited about 290 million years ago in a large lake in a mountainous area of what is now southwestern Germany, says Stephanie Klug, a paleontologist at the Museum of Natural History in Berlin. All creatures in this fossilized food chain represent known species, she notes. However, this is the first time that researchers have discovered direct evidence of a three-level aquatic food chain where all members were vertebrates.

The ultimate predator in the ancient gluttonfest was a 1-meter-long freshwater shark. Just before the shark died it had evidently swallowed two larval amphibians. The lengths of their skulls suggest that each animal, when alive, was about 30 centimeters long. This discovery is the first evidence that freshwater sharks preyed on amphibians, says Klug.

What completes the trifecta, however, are the heavily digested remains of a fish found inside one of the larval amphibians. Only the body and a few pieces of the fish's fins were preserved, but those fragments allowed the researchers to identify the species, recognize the remains as those of a juvenile, and estimate that it was about 15 cm long at dinnertime. —S.P.

PALEONTOLOGY

Deinonychus' claws were hookers, not rippers

Deinonychus and its relatives, a group of bipedal, meat-eating dinosaurs collectively known as raptors, gained a fearsome reputation because of the enlarged, sicklelike claw they had on each foot. Many paleontologists have presumed that the claw enabled the lithe predators to disembowel victims with a single slash, but two analyses suggest that the claws were instead used to grip and climb large prey.

Deinonychus' claw was about 10 centimeters long and curved through an arc of about 160°, almost a semicircle. In a previous study, Phillip L. Manning, a paleontologist at the University of Manchester in England, and his colleagues built a detailed model of the dinosaur's foot, equipping it with a claw made of aluminum sheathed in Kevlar and carbon-fiber composite. The researchers plunged the foot into a fresh pig carcass at speeds comparable to those expected during *Deinonychus* attacks.

Despite having a sheath 40 times as strong as the keratin that likely enveloped a *Deinonychus* claw, the model claw didn't rip a gash through the flesh. Instead, says Manning, the claw pierced the carcass and gripped the flesh but generated injuries no more than 40 millimeters deep. Those would be fatal for small prey, but trying to subdue a large dinosaur with such wounds "would be like trying to kill a person by stabbing them with plastic spoons," says Manning.

Manning's team has now developed a computer model of a *Deinonychus* claw that combines information gleaned from computerized tomography scans of fossils with data about the strength of bone and keratin. Results suggest that the claw could support the dinosaur's full 40-kilogram weight.

Manning and his colleagues suggest that raptors used their claws as climbing crampons. While latched onto the side of a large herbivore, the raptors could have used their teeth to inflict mortal wounds, they say. Lions today sometimes use a similar technique, hanging on to large prey by their claws while clamping their jaws around the victim's windpipe. —S.P.

PALEOBIOLOGY

Dinosaurs matured sexually while still growing

A distinct type of bone tissue preserved in the fossils of several species of dinosaurs suggests that the ancient reptiles were sexually mature long before they'd gained adult size.

In modern-day female birds, a thin layer of bone that's particularly rich in blood vessels—known as medullary bone—serves as a reservoir of calcium for eggshell production. The presence of medullary bone is a definitive sign of both female gender and sexual maturity, says Sarah Werning, a paleontologist at the University of California, Berkeley.

Scientists first reported finding this type of bone in a *Tyrannosaurus rex* fossil in 2005. Since then, says Werning, medullary bone has been identified in the fossils of several dinosaurs, including the meat-eating *Allosaurus* and the herbivorous *Tenontosaurus*.

Several teams of researchers have analyzed features akin to growth rings in the fossils of various dinosaur species in order to estimate how quickly those creatures grew and gained weight (*SN: 8/14/04, p. 99*). From such analyses, Werning and Berkeley colleague Andrew Lee conclude that the *Allosaurus* and *Tenontosaurus* specimens that include medullary bone—a sign they were sexually mature females—were 10 and 8 years old, respectively. Both dinosaurs were far short of adult size, she notes. In fact, each creature had died at an age when the typical member of its species was growing at its fastest rate. —S.P.

ANIMAL BEHAVIOR

Meet the old wolves, same as the new wolves

An analysis of fossils from southern California's La Brea tar pits hints that the dire wolf, a species that died out at the end of the last ice age, had a social structure similar to that of its modern-day relatives.

Dire wolves are the most common predators entombed at La Brea (*SN: 1/24/04, p. 56*). Adults were only slightly larger than today's gray wolves but had larger, broader heads and stronger teeth, which the creatures presumably used to crush bones (*SN: 7/27/02, p. 51*).

Sherri Gust, a paleontologist at Cogstone Resource Management in Santa Ana, Calif., analyzed the pelvic bones of almost 400 dire wolves excavated at La Brea. The degree and number of fusions in those bones, as well as their size, enabled her to estimate the age of each individual.

Of the fossils Gust analyzed, about 6 percent represented wolf cubs between 6 months and 1 year of age, and about 25 percent represented wolves that were nearly full grown. The largest category, young adults, comprised almost 39 percent of the individuals. Middle-aged wolves accounted for about 24 percent of the fossils, with the remaining 7 percent representing old members of the pack.

The prevalence of young adults in the sample, closely followed by adolescents and middle-aged individuals, suggests that they were the dominant members of the pack. That's the pattern seen in wolf packs today, says Gust. The absence of pups younger than 6 months of age hints that dire wolves, like their modern kin, kept the youngsters sequestered in dens and fed them by regurgitation. —S.P.

Books

A selection of new and notable books of scientific interest

IDENTICAL STRANGERS: A Memoir of Twins Separated and Reunited

ELYSE SCHEIN AND PAULA BERNSTEIN

Imagine being told at age 35 that you had an identical twin—a person whom you'd never met. This is what happened to Elyse Schein after she decided to search for her birth mother. Participants in a study comparing the effects of nature versus nurture, Schein and her twin sister, Paula Bernstein, had been separated at birth, adopted by two families, and given no knowledge of the other's existence. Once reunited, the sisters discovered that they shared much more than DNA. They had a common love for film and writing. Both battled depression during their teen years, a legacy of mental illness, they would find, passed on from their mother. The authors recount their outrage at their separation and describe attempts to hold the adoption agency legally accountable. Together at last, they detail their attempt to locate their birth mother. ***Random House, 2007, 270 p., color plates, hardcover, $25.95.***

AMERICAN CHESTNUT: The Life, Death, and Rebirth of a Perfect Tree

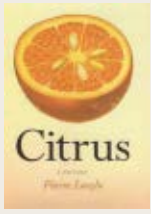
SUSAN FREINKEL

From Georgia to Maine, the American chestnut tree once reigned as a symbol of the country's rugged wilderness. A fungal blight imported from Asia, however, would eventually lay waste to some 4 billion chestnut trees and bring the proud tree to near extinction. Freinkel chronicles the history of the tree, the people who drew their livelihood from its high-quality wood, and the conservationists who are working with a near-obsessive passion to revitalize the chestnut population. Freinkel notes the close connection between rural people and the chestnut tree, which thrives mainly in the countryside. As early as 1880, scientists embarked on a crusade to save the American chestnut by cross-breeding hardier, blight-resistant varieties. Today, scientists are trying to genetically modify the deadly fungus to protect the few remaining American chestnut trees against future threats. ***Univ. Calif., 2007, 284 p., hardcover, $27.50.***

CITRUS: A History

PIERRE LAZLO

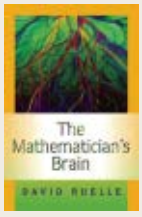
With orange juice a staple at the breakfast table and lemonade stands a childhood summer tradition, it is easy to forget that citrus used to be reserved for the wealthy, its scarcity making it a delicacy available only on special occasions. How did citrus arrive in the Western world and so quickly become a dietary staple? Citrus was brought to Europe from Asia, Lazlo explains, and introduced to the new world by the Spanish conquistadors, among others. Easily acclimating to the warm weather of Florida and California, the fruit soon changed the face of agriculture in the United States. In Florida alone, oranges are a $9 billion annual industry. Lazlo details steps that have been taken to domesticate citrus fruit and to protect it from catastrophic drops in temperature and insect infestation. The health benefits of citrus are legion: It not only protects against scurvy but provides a variety of vitamins. It adds zest to many foods, and Lazlo incorporates recipes using citrus throughout the book. Finally, Lazlo illuminates citrus' cultural role as a symbol in religion, art, and writing. ***Univ. Chicago, 2007, 252 p., color plates, hardcover, $25.00.***



THE MATHEMATICIAN'S BRAIN: A Personal Tour through the Essentials of Mathematics and Some of the Great Minds behind Them

DAVID RUELLE

British mathematician, logician, and cryptographer Alan Turing gained fame for breaking the Enigma cipher used by the German military during World War II. He was also a homosexual. During a period when being gay was against the law, he was arrested and convicted of "a gross act of indecency." Turing committed suicide in 1954. Ruelle includes Turing's tragic story among a diverse set of portraits of some of the most brilliant mathematical minds of all time. Among his other subjects is John von Neumann, co-creator of game theory who compared the digital computer to the human brain. The author, a mathematical physicist, reflects on how the mathematician works and how mathematics sheds light on the nature of knowledge. Ruelle also examines the anatomy of mathematical texts, looks at the process by which mathematical concepts are developed, and explores ideas such as infinity, the circle theorem, and algebraic geometry. ***Princeton Univ., 2007, 160 p., hardcover, $22.95.***



MICROCOSMOS: Discovering the World through Microscopic Images from 20X to over 22 Million X Magnification

BRANDON BROLL

The scanning-electron microscope (SEM) is a marvelous tool. Magnified 20 million to 22 million times, ordinary objects assume an other-worldly quality. The images, Broll explains, are examples of science "crossing over into art." This visually arresting collection, provided by the Science Photo Library of London, provides examples of SEM images from a wide variety of sources and arranged in six sections: microorganisms, botanics, the human body, zoology, minerals, and technology. Examples include the kiwi fruitlike appearance of the cell wall of plankton, the flowerlike folds of the fallopian tubes, and the colorful waves of butterfly scales. Broll's informative text highlights the noteworthy features of each image. ***Firefly, 2007, 422 p., hardcover, color photos, $29.95.***

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LETTERS

Waste not, want not

"Cellulose Dreams" (*SN: 8/25/07, p. 120*) ignored important research by David Tilman and Jason Hill of the University of Minnesota. They found that planting a crop of 18 different native prairie plants grown in highly degraded and infertile soil with little fertilizer or chemicals yielded substantially more bioenergy than a single species in fertile soil. In fact, their crops substantially improved the quality of the soil and sequestered carbon to boot. Their results were published in the Dec. 8, 2006 *Science*. The researchers noted that resultant hay is a high-value energy source that can be converted into biofuel or mixed with coal for electricity generation.

CARL NASH, WASHINGTON, D.C.

I don't know whether to laugh or cry when I see President Bush's oft-cited goal of cutting gasoline usage by 20 percent in 10 years. A 20 percent reduction is available overnight by simply reestablishing a nationwide 55 mph speed limit and enforcing it with speed governors on all public road vehicles. I tested this on several road trips this summer. When I drove a maximum of 55 mph I got about 20 percent better fuel economy than when I drove near the posted speed limit. Substituting fuel production for food production doesn't make sense to me. We just need to drive more slowly.

BUD HENDERSON, KNOXVILLE, IOWA

Your story, like many I've read recently, argues that high-cellulose crops are a better choice than corn for producing ethanol. I suspect that millions of homeowners would cheerfully add their grass clippings and autumn leaves to the stockpile of poplar, switchgrass, and wheatgrass intended for biofuel generation.

A.C. GROVER, SOUTHBURY, CONN.

Turn it down

Researchers may only recently have discovered that female zebra finches are more likely to flirt with strangers when background noise goes up ("High Volume, Low Fidelity," *SN: 8/25/07, p. 116*), but young male humans seem to have known that about females of their species for eons.

JIM SCHNERINGER, DALLAS, TEXAS

Correction *"Better than Pap"* (SN: 10/20/07, p. 172) *erroneously described the human papillomavirus (HPV) test for cervical cancer as a blood test. In fact, like the Pap smear, it is performed on a sample of cervical cells.*

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Use them as a concert hall – or a sanctuary.

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QC2 headphones (left). QC3 headphones (right).

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