SCIENCE NEWS
THE WEEKLY NEWSMAGAZINE OF SCIENCE

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lucy junior found
health toll of shift work
real tan in a tube
hawaiian crickets go quiet

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monster star

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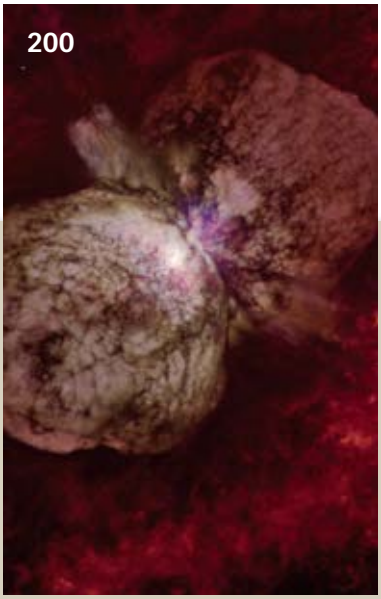

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Cover The massive star Eta Carinae ejected some 20 suns' worth of material in a giant eruption about 150 years ago. A new theory suggests that most massive stars eject the bulk of their material in a series of such outbursts just before the ends of their 3-to-4-million-year lives. (N. Smith, NASA) Page 200

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SCIENCE NEWS
This Week

Evolution's Child

Fossil puts youthful twist on Lucy's kind

As fossil hunters crossed a dusty slope of Ethiopia's Dikika region on Dec. 10, 2000, one noticed a child's face bones poking out of the ground. Now, after years of painstaking work to remove the ancient individual's skull and some of the other bones from sandstone, researchers have announced that this discovery represents the oldest and most complete fossil child in our evolutionary family.

The nearly complete skeleton, missing only the pelvis and a few other bones, comes from a 3-year-old *Australopithecus afarensis* female who died about 3.3 million years ago, say Zeresenay Alemseged of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and his colleagues.

"This [new fossil] is something you find once in a lifetime," says Zeresenay.

The Dikika child's skeleton has not yet been entirely removed from the surrounding rock. Zeresenay's team plans to compare it with Lucy, the 3.2-million-year-old partial skeleton of an adult female *A. afarensis*, which was unearthed in 1974.

The researchers found the child's skeleton between previously dated volcanic-ash layers. A flood apparently covered the child's body in sand and pebbles, protecting it during fossilization. Comparisons of the youngster's teeth with those of people and chimpanzees yielded the estimate of age.

The Dikika girl displays a brain size about equal to that of a 3-year-old chimpanzee, the investigators report in the Sept. 21 *Nature*. However, the ancient child's brain grew more slowly than brains of chimps or other apes do, comparisons with adult *A. afarensis* and ape skulls reveal.

The parts of the specimen that have so far been removed from the sandstone include the hyoid, a small neck bone. The Dikika girl's hyoid resembles hyoids of living nonhuman apes, suggesting that she possessed air sacs in her neck as apes do, says coauthor Fred Spoor of University College London. The function of air sacs in apes is unclear.

The shape of the Dikika girl's thighs and shins indicate that she walked upright, even at age 3, the researchers hold. However, several apelike lower-body traits support the view—hotly debated over the past 25 years—that *A. afarensis* sometimes climbed in trees, perhaps to make nests or to avoid predators, Spoor says.

For instance, as in other *A. afarensis* specimens and chimps, the new specimen's finger bones are long and curved. Computerized tomography images of the inner ear show semicircular canals, crucial for maintaining balance, like those of chimps.

Finally, and surprisingly, the Dikika girl's shoulder blades and those of gorillas look much alike, the researchers assert. Spoor regards that scapula as evidence of an "all-purpose" shoulder that allowed for climbing.

YOUNG BUT OLD **The Dikika child's flat nose and projecting face look chimplike, but the Ethiopian fossil comes from a 3.3-million-year-old human ancestor that belongs to the same species as the famous Lucy skeleton.**

A. afarensis "was unlikely to have been restricted to walking on two feet," remarks anthropologist Bernard Wood of George Washington University in Washington, D.C.

The Dikika girl's scapula indeed resembles scapulas of gorillas, although the implications of this trait for tree climbing await complete analysis of the skeleton, says anthropologist Daniel E. Lieberman of Harvard University.

"This skeleton is really important because it's so complete," comments anthropologist Tim D. White of the University of California, Berkeley. "But it's a black box until it's been fully cleaned and properly analyzed." —B. BOWER

Graveyard Shift

Prostate cancer linked to rotating work schedule

Men who alternate between daytime and nighttime shifts on their jobs have triple the normal rate of prostate cancer, according to a Japanese nationwide study.

A variable employment schedule, which can upset daily hormone-production cycles, had previously been linked to breast cancer and, in one study, to colorectal cancer in women. The new finding supports a longstanding expectation that disrupting 24-hour biological rhythms can cause tumors in men too.

The study is the first solid evidence tying shift work to prostate cancer, says neuroendocrinologist David Blask of the Bassett Research Institute in Cooperstown, N.Y.

To investigate the possibility that shift work might put men at risk, Japanese researchers led by urologist Tatsuhiko Kubo of the University of Occupational and Environmental Health in Kitakyushu gathered data in the late 1980s on some 14,000 cancerfree men who were between 40 and 65 years old. Eighty percent of them worked daytime schedules, 7 percent worked nights, and 13 percent rotated between day and night hours.

During the study, which tracked the men for nearly a decade, prostate cancer was diagnosed in 21 daytime workers, 3 nighttime workers, and 7 shift workers.

After taking into account the influence of body weight, smoking habits, alcohol consumption, and other variables, the researchers calculate that annual prostate-cancer incidence was three times as high among rotating-shift workers as among daytime workers. By contrast, nighttime-only and daytime-only workers didn't have significantly different cancer rates, the researchers report in the Sept. 15 *American Journal of Epidemiology*.

"Those of us interested in circadian rhythms and cancer predicted this a long time ago," says epidemiologist Richard Stevens of the University of Connecticut Health Center in Farmington.

One possible explanation for the shift-work effect is that the hormone melatonin might protect men against prostate cancer, says Stevens. People produce less of that hormone when they are exposed to light during their usual sleep periods.

Blask has already shown that melatonin slows the growth of human-breast tumors (*SN: 1/7/06, p. 8*), and he plans to test the hormone's effects on prostate tumors.

Meanwhile, William Hrushesky of the Dorn Veterans Affairs Medical Center in Columbia, S.C., is examining whether melatonin supplements can fight prostate cancer.

Neither Blask nor Hrushesky is surprised that men in the Japanese study who consistently worked at night had normal cancer risk. "Their melatonin rhythm and circadian system have adapted to a reverse cycle," Blask speculates.

Blask notes a caveat to the new analysis: Diet can influence prostate cancer, and the Japanese study didn't determine whether the rotating-shift workers had less healthful diets than other men. Nevertheless, Blask says, "the shift-work issue isn't just for women anymore." —B. HARDER

Enigmatic Eruptions

Gamma-ray bursts lack supernova fireworks

Gamma-ray bursts, the most powerful explosions in the universe, just got more mysterious. New observations challenge the theory that astronomers had constructed for the origin of many of these cosmic flashbulbs.

These flashes of high-energy radiation are a million trillion times as bright as the sun. According to the leading theory, any gamma-ray burst lasting more than 2 seconds is associated with a supernova, the explosive death of a massive star. A high-speed jet of material emerging from the collapsing star, which becomes either a neutron star or a black hole, generates the burst. At about the same time, a wind or shock wave carrying radioactive nickel-56 powers the visible supernova.

Most bursts are too far away for telescopes to see the underlying supernovas, but stellar explosions have been identified for four of the closest known bursts.

Now, however, three teams report online (*see www.sciencenews.org/articles/20060923/fob3ref.asp*) that two bursts, seemingly nearby, appear to have no supernova associated with them.

One team studied a burst recorded on May 5, while all three groups examined a burst seen on June 14. In each case, the researchers assert that the burst originated from a galaxy relatively close to the Milky Way.

In a thorough search with several telescopes, the groups failed to find a supernova associated with the June 14 event. "This is the first clear evidence that long-duration gamma-ray bursts can be either associated with supernovas which do not have [the usual] properties or they can be produced by a different phenomenon," note Massimo Della Valle of the INAF-Astrophysical Observatory of Arcetri in Firenze, Italy, and his colleagues.

Another group, which includes Shri Kulkarni of the California Institute of Technology in Pasadena, suggests that the June 14 burst may belong to a previously unknown class. A third team, which includes Johan Fynbo of the University of Copenhagen, concludes that both bursts have enigmatic origins.

Two theorists who developed the prevailing models for long-duration gamma-ray bursts say that there may be a simple explanation. Associated supernovas perhaps weren't visible because not enough nickel-56 was available during the explosions, says Andrew MacFadyen of the Institute for Advanced Study in Princeton, N.J. Either too little of the isotope is produced or it falls into the newly formed black hole, he says.

Stan Woosley of the University of California, Santa Cruz agrees. "The evidence is quite solid that most of the long gamma-ray bursts seen so far come from the deaths of massive stars," he says.

The findings highlight the diversity of stellar explosions, MacFadyen adds.

Meanwhile, two papers posted online by a team at Yale University and by Brad Schaefer of Louisiana State University in Baton Rouge claim that the June 14 gamma-ray burst is much farther away than the three teams reported. But Kulkarni and his collaborators calculate they are 98.5 percent certain that the nearby galaxy is the burst's home. —R. COWEN

NASA, SKYWORKS DIGITAL

BURST BEGINNINGS At the start of a gamma-ray burst, a collapsing star launches jets of matter.

UV Blocker

Lotion yields protective tan in fair-skinned mice

A lotion that stimulates production of the skin pigment melanin induces a deep tan in specially bred laboratory mice. Those mice have skin similar to that of red-headed, fair-skinned people, who are notoriously poor tanners.

The animals developed their tans without being exposed to the sun and its ultraviolet (UV) rays. Further tests showed that the additional melanin protected the mice against UV-induced DNA damage, sunburn, and skin cancer.

The active ingredient in the lotion is forskolin, an Asian plant extract that has been used to treat health problems. But scientific studies of the compound in the past few decades have shown no clear benefit, says study coauthor David E. Fisher, an oncologist at the Dana-Farber Cancer Institute and Children's Hospital in Boston. Nevertheless, past tests had shown that forskolin can rev up production of cyclic AMP, a molecule that's instrumental in producing melanin.

Normally, melanin manufacture requires several steps. When sunlight's UV rays hit the skin, cells release a signaling compound that binds to proteins on the surface of melanocytes, the cells that make melanin. This docking activates cyclic AMP production inside the melanocyte, which spurs the cell to make melanin and distribute it to nearby skin cells.

There, melanin forms an array of microscopic parasols over the skin cells' nuclei, shielding the DNA from ultraviolet rays. The melanin darkens the cell and reduces burn risk.

In the new study, Fisher and his team used mice that, like red-headed people, have surface proteins on their melanocytes that are poor docking stations for the signaling compound. That interrupts melanin production.

Mice coated with the forskolin lotion for 3 weeks made more melanin and became

dramatically darker than mice getting a neutral lotion.

Untreated mice exposed to UV rays for 24 hours had more than 20 times as much DNA damage and sunburn as did mice that had been treated with forskolin. After 20 weeks of exposure to UV rays for an hour or so each day, untreated mice developed nearly twice as many skin tumors as did the treated mice, the scientists report in the Sept. 21 *Nature*.

The results show that "the reduced DNA damage has a [positive] biological consequence," says molecular biologist Richard A. Sturm of the University of Queensland in Brisbane, Australia. Increased melanin reduced death among skin cells.

Studies had previously established that people with dark skin are less likely to become sunburned or get skin cancer than fair-skinned people are. With the new work, Sturm says, Fisher and his team "display the tangible proof ... for a photo-protective role of melanin."

Sturm is cautious about the possibility of providing people with a forskolin-containing cream. He notes that cyclic AMP can stimulate cell growth, so increased amounts of that molecule might pose a cancer risk.

Fisher is cautious too. "I am far from certain [that such a cream] would have activity in human skin," he says. Still, the findings suggest that intervening in the melanin-production process has potential as a cancer preventive, he says.

"If [forskolin] turns out to be safe and acceptable for human use, it can only be helpful," says dermatologist Barbara A. Gilchrest of Boston University School of Medicine. —N. SEPPA

Crickets on Mute

Hush falls as killer fly stalks singers

Within just 5 years, singing has nearly died out among a population of cricket on a Hawaiian island, researchers report.

A mutation for silence has spread so fast because an invasion of deadly flies finds male crickets to attack by following their chirps, says Marlene Zuk of the University of California, Riverside.

However, female crickets also listen for chirps to find the males, so a guy who can't sing has a problem. The mute males seem to be coping, at least temporarily, by clustering around the few remaining chirpers, Zuk and her colleagues report in a *Biology Letters* paper released online.

"What surprises me most is that the cricket song went away so fast," says Ron Hoy of Cornell University, who also studies crickets and the song-tracking fly. "Natural selection is coming down like a hammer," he says.

DON'T SING NOW ***Ormia ochracea*** **flies pinpoint the source of a cricket chirp, and a female deposits larvae on the unlucky songster. Consequently, male crickets on Kauai are falling silent.**

The crickets (*Teleogryllus oceanicus*) that are losing their songs came to Hawaii from Australia and western Pacific islands. Their nemesis, the *Ormia ochracea* fly, invaded the Hawaiian Islands from North America. These flies are about the size of houseflies but have big red eyes and fly at dawn or dusk.

"You've never seen them," says Zuk. "You don't have anything they want."

In 1975, William Cade, now of the University of Lethbridge (Alberta), reported that the female fly follows cricket chirps to deposit larvae on a male. The larvae dig in and eat the cricket from the inside.

Zuk and her colleagues found in the 1990s that Kauai had intense fly infestations, parasitizing one-third of the crickets. In her 2001 survey, she heard only one male calling.

In 2003, Zuk didn't hear anything in her night searches. Then, she says, "suddenly, in my headlamp, I start seeing crickets." For insect biologists, quiet, nighttime male crickets are shocking. "It's like finding out that peacocks dropped their tails," Zuk says.

She found that the cricket population on Kauai was higher than it had been for years, but few males still had wings with functional chirping equipment. When coauthor Robin Tinghitella, also of Riverside, bred those crickets, she concluded that the silence came from changes in only a gene or two.

When the researchers broadcast recorded cricket chirping, they found that the mutant males hopped unusually close to the speakers. Lurking near a chirping male is probably their only way to meet females, says Zuk.

Once a female arrives, a male cricket normally produces a special, soft courtship chirp to persuade her to mate. Theorists have proposed that females of island species tend not to be too choosy. As Zuk puts it, "If there are only four guys and you don't like any of them, you die, and so do your genes."

Zuk's work gives "the most dramatic example yet of how flies have shaped communication in crickets," says Cade. —S. MILIUS

Flying with Their Legs

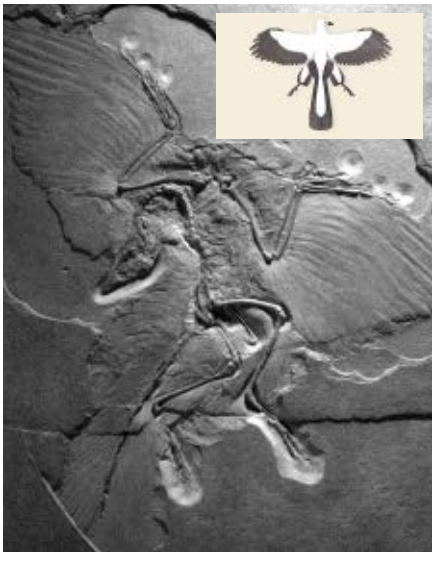
Hind feathers made primitive bird nimble

The earliest-known bird may have soared ancient skies on four wings. Feathers covered the legs of *Archaeopteryx*, a creature that lived 150 million years ago and had wings like modern birds but teeth and claws like dinosaurs. A new report argues that *Archaeopteryx* used these leg feathers to improve its flight.

Scientists had assumed that the *Archaeopteryx*'s leg feathers were for warmth and streamlining. But when Nick Longrich of the University of Calgary in Alberta reexamined a fossil of the creature, he found that its leg feathers resembled the ones that keep modern birds aloft. Thus, he argues in the summer (September) issue of *Paleobiology*, the legs functioned like small auxiliary wings, providing extra lift that made the creature more nimble in the air.

Longrich became interested in *Archaeopteryx*'s hind limbs 3 years ago, when a primitive-bird fossil was discovered in China. It had large feathers on its legs that its discoverers argued played a role in flight (*SN: 1/25/03, p. 51*). He wondered whether the same was true for *Archaeopteryx*. "It had never occurred to me to look at the hind limbs," he says.

An *Archaeopteryx* fossil found in 1877



FLYING FEATHERS **Reexamination of a fossilized *Archaeopteryx* reveals that the creature had feathers on its legs that may have helped it fly. Inset shows how the *Archaeopteryx* may have looked with feathers.**

HOY AND G. HALDEMAN; LONGRICH

had initially shown feathers on its legs. But those feathers obscured the bone, so they were stripped away when the relic was prepared for display.

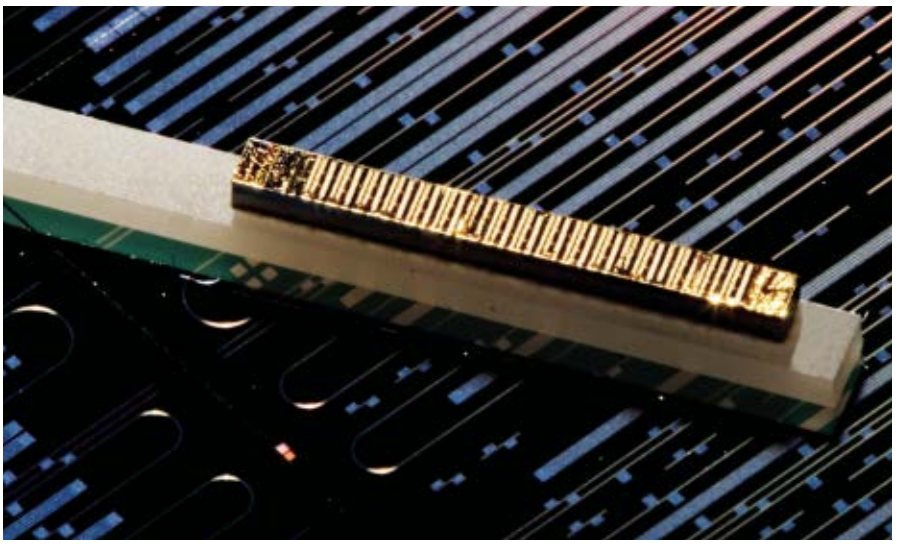
Evidence of the feathers still existed, though. When paleontologists split the rock to reveal the fossil, the face opposite the bone retained a counterimpression—including the leg feathers. When Longrich examined this slab, which had been in storage at the Humboldt Museum in Berlin, he saw the leg feathers.

Longrich was uncertain whether the feather-covered rear legs could splay outward, mimicking the position of the wings, or whether the creature's hips kept its back legs straight down, unable to assist in flight. Longrich combined digital photographs of the fossil's counterimpression to make a computer model of *Archaeopteryx*'s flight. He found that the hind legs could provide significant lift even if they couldn't splay fully outward.

If the feathered legs were held out at 45 degrees, they would enable *Archaeopteryx* to turn 9 percent more sharply than if the creature's legs didn't aid its flight. That position would also reduce by 5 percent the speed at which the bird could fly before it stalled and fell from the air. If the feathered legs were held out at a full 90 degrees, they would decrease the turning radius by 12 percent and the stall speed by 6.5 percent.

"It is an interesting hypothesis, but it's relatively speculative," says Peter Makovicky of the Field Museum in Chicago. He notes that hind-limb feathers were apparent on only 1 of the 10 *Archaeopteryx* fossils that have been discovered.

Luis Chiappe of the Natural History Museum of Los Angeles County says he's "not convinced" by Longrich's arguments. Hind-limb feathers of *Archaeopteryx* could be similar to those of eagles and not play a strong role in flight. —J. REHMEYER



LASER LINEUP Researchers have developed a new kind of tiny laser, more than 30 of which huddle side by side along this silicon bar (gold). The technology may lead to cheap optical connections that could dramatically boost data flows between and within computers.

Long-Sought Laser?

Standard microchips may gain speedy optical connections

Even with fast personal computers, Internet goodies such as videos and podcasts often download at sluggish speeds. Now, an advance in laser technology promises to eliminate those and other nagging computer delays, its developers say.

Engineers have long known how to wipe out such delays: Outfit ordinary computers with circuitry that sends and receives data as modulations of light rather than as electricity. Optical connections—those used for long-distance telecommunications, for instance—carry far more data than the metal wires that form short-range connections between computers, circuit boards, and chips do. Yet no one has built from ordinary silicon all the light-processing, or photonic, components needed to make cheap optical links for short-range uses.

In recent years, engineers have begun to develop some key silicon photonic devices (*SN: 10/30/04, p. 275*). Although researchers have invented silicon lasers, they can't run on electrical power and so require an external laser for energy (*SN: 3/19/05, p. 189*).

A new type of laser has now cleared that hurdle, its inventors claim. The laser was unveiled at a Sept. 18 press conference by a team at the University of California, Santa Barbara and Intel Corp. of Santa Clara, Calif. (Intel is the title sponsor of some of the educational programs of Science Service, publisher of *Science News*.)

Although not made exclusively of silicon, the device runs on electricity and could be mass manufactured in the same factories as silicon microchips are, the researchers say.

"Perhaps most important is its potential to be realized on a silicon photonics chip at low cost," comments opto-electronics engineer Graham T. Reed of the University of Surrey in England.

Typically, manufacturers create microchip lasers from exotic—and expensive—semiconductor compounds such as gallium arsenide or indium phosphide. Such compounds readily convert electricity to light, whereas silicon tends to generate heat.

On the other hand, silicon performs exceptionally well as a conductor of light at the infrared wavelengths used for telecommunications, says Mario J. Paniccia, head of Intel's group on the invention team.

Tapping the strengths of both kinds of semiconductors, the researchers etched a silicon wafer to create horizontal, rodlike, light-conducting structures, called waveguides. Then, at a temperature low enough to be compatible with silicon-microchip processing, they bonded atop that wafer a matching wafer composed primarily of indium phosphide, explains John E. Bowers, who led the Santa Barbara engineering group.

Next, the team cut up the wafers to yield laser chips in which an applied voltage makes the indium phosphide layer produce light. In each laser—less than a millimeter long and about a thousandth of a millimeter wide—the light then bounces between the indium phosphide layer and silicon waveguide beneath it, intensifying until it shoots out the end of the waveguide as a laser beam. Such a beam could potentially carry hundreds of times as much information as an electronic signal does. A report of the research appears in the Oct. 2 *Optics Express*.

The new hybrid design combines "the best of both worlds," comments laser engineer Alan E. Willner of the University of Southern California in Los Angeles.

Stay tuned, advises physicist Richard A. Soref of the Air Force Research Laboratory at Hanscom Air Force Base in Massachusetts. He notes that the quest for an electrically powered, all-silicon laser is still going strong. —P. WEISS

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Dr. Goodman is exactly the guide you want on this tour—he is clear but comprehensive, objective but humane, learned but light-hearted. He received his undergraduate degree from Harvard University and his Medical Doctorate from Cornell Medical College. He completed his surgical training and Chief Residency at the Harvard Surgical Service of Boston City Hospital. Dr. Goodman is a Fellow of the American College of Surgeons and a Diplomate of the American Board of Surgery. Currently, he teaches gross anatomy in the W.W.A.M.I. Medical Sciences Program at Montana State University.

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TEMPERAMENTAL MONSTERS

Massive stars may slim down in eruptive bursts

BY RON COWEN

"[I]t is now again on the increase. It is, and has been for a month, brighter than [the star] Canopus. Half-way indeed between him and Sirius, and very red."
—Astronomer Charles P. Smyth, from letter dated Jan. 1, 1845

Late in 1837, a dim Milky Way star called Eta Carinae suddenly blossomed and soon became the second-brightest star, next to Sirius, in the night sky. During the next 19 years, a period now known as the Great Eruption, the star ejected two billowing, mushroom-shaped gas clouds, each 100 times as wide as our solar system and containing enough mass to make 10 suns.

Eta Carinae suffered another substantial, but less dramatic, eruption in 1890, and evidence is accumulating that it had undergone several other severe outbursts during the past 10,000 years. Even today, the star, which tips the scale at a whopping 100 solar masses, hurls the equivalent of two Earths of gas and dust into space each day.

Although the outbursts have made Eta Carinae a striking spectacle, astronomers have long regarded the star as a freak of nature. Astronomical models indicate that most heavyweights expel large amounts of matter before they die, but that they eject this material relatively slowly, over their entire 3-to-4-million-year lifetimes. But new evidence—a combination of theory and observations—suggests that Eta Carinae's temperamental behavior may be the norm, not an anomaly, among extremely massive stars.

Simulations indicate that the first stars to form were all extremely massive. Because these stars were the main sources of every element heavier than helium in the early universe, the evidence of widespread temperamental behavior may prompt a new look at how the cosmos acquired its assortment of chemical elements, including those necessary for life. The findings may in particular shed new light on the fate of the first stars in the universe.

"There's a paradigm shift in our understanding of massive stars" that may affect views of how these stars live and die, the remnants they leave behind, and their contribution to the chemical makeup of the early universe, says Nathan Smith of the University of the California, Berkeley.

ROUGH NEIGHBORHOOD — This star-forming region, called the Carina nebula, is home to the massive, temperamental star Eta Carinae (brightest object in image).

SMITH

WINDS OF CHANGE All massive stars lead short lives. The heaviest ones have a life span only about a thousandth of that of a star such as the sun. They can weigh 50 to 150 times the mass of the sun at birth, but during their life spans, they lose much of that mass via a steady, outgoing wind. Eventually, they die a fiery death in an explosion called a supernova. Before exploding, these stars, then known as Wolf-Rayet stars, have lost their outer atmosphere and slimmed down to a mere 10 to 20 times the mass of the sun.

Until the explosion, the stars burn hydrogen at their cores, transforming it into helium. The nuclear reaction creates ultraviolet (UV) radiation, which ionizes an array of elements in the stars' outer layers. These ionized atoms absorb the radiation, and the kick imparted by the process blows off gas, creating a continuous, outward flow of matter. But just how much mass those winds carry away is now an open question, Smith and others say.

Astronomers had assumed that the UV-absorbing ions are distributed smoothly and uniformly throughout a star's outer layers. Calculations using that assumption show that the winds are indeed intense enough to put heavy stars on a slow but steady diet, reducing their mass by tens of solar masses over several million years.

Recent studies indicate that observers may have overestimated the strength of stellar winds. The new data show out that the material that absorbs radiation is unevenly distributed in the atmospheres of stars.

Researchers measure the brightness of a star to deduce the amount of mass carried off by a wind. The greater the emission, the larger the mass loss. But an atmosphere that consists of dense clumps of ions will radiate more strongly than an atmosphere containing the same amount of material distributed more uniformly. If astronomers don't account for the higher intensity of light emitted by a clumpier atmosphere, they can be fooled into thinking that the wind carries away more mass than it really does.

"Currently accepted mass-loss rates may need to be revised downward as a consequence of previously neglected clumping,"

note Joachim Puls of the University of Sternwarte in Munich and his colleagues in a review article recently posted on the Internet (*http://xxx.lanl.gov/astro-ph/0607290*).

According to Smith, Stanley P. Owocki of the University of Delaware in Newark, and other researchers, the total wind may be only one-tenth as strong as models had indicated. That's too gentle to blow away all the matter that astronomers know must be expelled by massive stars before they explode.

"Steady winds are simply inadequate for the envelope shedding needed to form a Wolf-Rayet star," Smith and Owocki note in the July 1 *Astrophysical Journal Letters*. Smith also reviewed the evidence for episodic outbursts among heavyweights in May at a meeting on massive stars at the Space Telescope Science Institute in Baltimore.

IS ODD NORMAL? Instead of the weight-loss-by-wind theory, researchers now propose that most extremely massive stars slim down by undergoing extraordinarily violent eruptions like the one that convulsed Eta Carinae in the mid-1800s.

The eruptions would occur during the era just before a massive star enters its Wolf-Rayet phase. During this stage, heavy stars such as Eta Carinae are known as luminous blue variables. This phase lasts for less than 100,000 years—a mere blink in astronomical time.

One eruption wouldn't be enough to shed all the mass, but several at different times during the entire luminous-blue-variable era would suffice, Smith proposes.

His idea is more than just a pie-in-the-sky theory. For example, nested shells of material surrounding the mushroom-shaped clouds recently cast out by the star suggest that Eta Carinae had in fact suffered previous outbursts over several thousand years. There's compelling circumstantial evidence that the star had undergone eruptions similar to the one witnessed some 150 years ago, says theorist Mario Livio of the Space Telescope Science Institute.

STAR SHELLS — Shells and blobs of material surrounding the massive star P Cygni indicate that it might have undergone a series of outbursts over the past 100,000 years. Each might have been a miniversion of the huge eruption of Eta Carinae in the 19th century.

J. MAEBURN ET AL.

Astronomers don't fully understand what set off Eta Carinae, but a few other stars seem to have undergone similar outbursts. A Milky Way star called P Cygni, which brightened and shed a tenth of a solar mass in 1600, may have undergone even fiercer outbursts over the past few thousand years, Smith and others note. Furthermore, astronomers have recently identified in other galaxies several stars that they call "supernova imposters." These stars haven't yet blown themselves to bits in supernovas, but their eruptions are extremely bright and energetic.

Indeed, some of these stars resemble models of what an Eta Carinae–like eruption might look like a few thousand years after it happened, notes astrophysicist Paul Crowther of the University of Sheffield in England.

What's more, shells of material that surround some bona fide supernovas indicate that these once-massive stars ejected large amounts of material only a few thousand years before they exploded.

The challenge to proving Smith's hypothesis, adds Crowther, is the brevity of the luminous-blue-variable era. Massive stars are rare, and it's hard to find one that is actually in that brief phase of evolution. "We have only a very small number of these objects to play with," Crowther says.

While acknowledging the merits of Smith's work, Crowther says that he's not entirely swayed by the arguments. In the old scenario, he notes, winds accounted for all the mass lost by heavy stars. In the new picture, powerful eruptions over a short time either replace or overshadow the wind scenario.

"Nathan [Smith] sells a great story," says Crowther, but "I think the reality is somewhere in between" those two pictures.

BIG PAYOFF The recognition that massive stars may shed a significant amount of their heft through brief eruptions is likely to change the way astronomers think of these heavyweights, Crowther.

The presumed temperature, composition, turbulence, and other properties of these stars must differ if they expel most of their mass in a few late-stage, concentrated bursts rather than steadily throughout their lives, Smith agrees. Those properties, in turn, determine when a star finishes burning its main fuel, hydrogen, and how long it lives.

Determining when in its life a massive star spews material is crucial for understanding the chemical composition of the universe. Stars produce heavier elements as they age, fusing hydrogen into helium, helium into carbon, and carbon into oxygen. A steady wind driving out material early in the life of a star would litter the cosmos with lighter elements than would a series of late-stage eruptions. It's too soon to tell exactly how this would alter estimates of the chemical contents of the cosmos, but the consequences are likely to be most dramatic early in the universe, says Smith.

Current theory holds that the first stars in the universe were much heavier than stars are today and that they ranged from 100 to several hundred times the mass of the sun. Those early stars contained only the elements forged in the aftermath of the Big Bang: hydrogen, helium, and traces of lithium. According to the old stellar-wind model of mass loss, the first stars wouldn't have shed any material before dying as supernovas because the winds are generated only by the absorption of radiation by heavier elements.

In Smith's eruption model, these stars would expel some material a few thousand years before they die as supernovas rather than stockpiling all of it until the bitter end. That's because the proposed eruptions don't depend on whether the star has made heavy elements. "The main question is whether a [first-generation] massive star shed most of its mass before or during a supernova event," notes Smith.

A series of episodic Eta Carinae–like eruptions would have decreased the weight of early stars before they finally exploded as supernovas, perhaps influencing the type of supernovas they became.

According to most theorists, many of the heaviest stars in the early universe were obliterated by their explosions and blasted into space every heavy element that they had forged. But with less mass, some of those stars would be more likely to have left behind an ultradense cinder—a black hole—when they became supernovas. Several solar masses of iron and perhaps a few other heavy elements would be trapped inside the black holes and never make their way out into interstellar space.

Livio says that if eruptions such as those of Eta Carinae were common among the most-massive stars, "it may change significantly the [assumed] end products of those stars, including black holes and supernovas." ■

CALLING DEATH'S BLUFF

Implantable defibrillators can save thousands of lives—but which ones?

BY BEN HARDER

Some hearts seem to be beating normally one moment, but then quiver for an instant and fall still forever. In these cases, the heart's electrical circuitry goes haywire, and its contractions accelerate until the organ flails uselessly and shuts down. Sudden cardiac death awaits nearly half a million people nationwide in the next 12 months. Once a person's heart stops, there is usually little that any hospital can do.

However, doctors do have an earlier chance to intervene. By implanting a specialized device into a person's chest, they can equip the heart to recover instantly when death comes knocking. When the electrical leads of these so-called implantable cardioverter-defibrillators, or ICDs, detect an abnormal heart rhythm, the attached pager-size generator delivers a shock that restores the normal cadence.

Use of these devices began in the 1980s and has increased exponentially in recent years. This year, U.S. doctors will surgically implant some 200,000 defibrillators at a cost of about $30,000 to $50,000 per operation.

Yet most of the devices will never see action. About four-fifths of defibrillators sit quietly in people's chests until their batteries conk out. Replacing a battery, which is necessary every 5 years or so, requires another round of surgery.

Defibrillators also can be cantankerous. They sometimes mistake mild arrhythmia, or rhythm disruption, for a deadly spasm and shock the heart unnecessarily, causing pain but no permanent harm. And while some people die because a device fails to fire when it should—a problem that spawned massive recalls of certain models last year—many more perish because no one recognized that a defibrillator could have saved their lives.

Doctors would like to improve their ability to distinguish people who truly need defibrillators from those who don't. The current method uses a crude measure: the heart's mechanical efficiency at pumping blood. That value, called ejection fraction, has no direct relationship with the heart's electrical circuitry.

Recent studies suggest that measures of the heart's electrical function and its responsiveness to the nervous system may reveal additional information about the heart's vulnerability to arrhythmia. Medical researchers recently concluded the first systematic test in which they weighed one such promising factor—an electrical characteristic called T-wave alternans—for deciding who should get a defibrillator. They plan to announce their results at a medical meeting this November.

If such trials prove that T-wave alternans and other new measures can supplement ejection fraction in clinical evaluation of patients, doctors may save more lives even though they implant fewer devices than they do now.

HIGH PRICE AT THE PUMP With each contraction of the heart, the organ's left ventricle squeezes blood into the body's arteries. A healthy chamber pumps out half to three-quarters of its contents, while a defective heart might expel 30 percent or less. This ejection fraction, expressed on a 100-point scale, can be gauged painlessly by performing a sonogram of the chest.

An insult such as a myocardial infarction—commonly called a heart attack—causes muscle damage that can instantly trigger fatal arrhythmia, or it can permanently reduce ejection fraction. The same muscle damage can also interfere with the conduction of electrical impulses through the heart, thereby increasing the chance that a subsequent life-threatening arrhythmia will occur.

"Ejection fraction has been studied extensively and is clearly associated closely with sudden death," says cardiac electrophysiologist David S. Rosenbaum of Case Western Reserve University's MetroHealth Campus in Cleveland.

The form of arrhythmia that usually triggers cardiac arrest is called ventricular fibrillation. In that event, uncoordinated muscle contractions cause the ventricles to flutter ineffectually. The malfunction develops when electrical impulses that control the pace and rhythm of the ventricles' contractions become irregular.

> "The lethal event is electrical—a catastrophic disturbance in rhythm."
>
> — RICHARD VERRIER, BETH ISRAEL DEACONESS MEDICAL CENTER

"The lethal event is electrical—a catastrophic disturbance in rhythm," says Richard Verrier, a cardiovascular electrophysiologist at Beth Israel Deaconess Medical Center in Boston.

That's precisely the problem that defibrillators are designed to solve. People with an ejection fraction lower than 30 have been shown to benefit from defibrillators, so physicians currently use that value as a threshold when deciding who should get a device. With that cut-off and other criteria, such as previous ventricular fibrillation or advanced heart failure, about 1.6 million people in the United States are eligible, according to Minneapolis-based device maker Medtronic.

Yet ejection fraction reveals limited information about the heart's electrical integrity. "You can have a lethal disturbance without having any [preexisting physical] damage to the heart," Verrier notes. Or, the organ can have damage that never leads to an arrhythmia.

"You're using a measure of mechanical abnormality to predict an electrical event, so you can't expect it to be overwhelmingly accurate," says Rosenbaum. "Doctors have to implant 17 defibrillators to save one person. The benefit is real, but it's modest and has to be weighed against the risk."

Hazards of the surgery include infections, clots, and internal bleeding. And when devices fire unnecessarily, patients "get a flurry of shocks," says cardiologist J. Thomas Bigger Jr. of Columbia University's New York–Presbyterian Hospital.

PROBING THE CIRCUITRY In 1994, researchers led by Rosenbaum determined that hearts that go into arrest tend to have a history of beat-to-beat fluctuations in the size of the T wave. That wave is a small blip on the familiar trace of an electrocardiogram (EKG), and it reflects the electrical recharging of the heart between beats.

Today, doctors examine T waves by attaching electrodes to a patient's chest as he or she exercises on a treadmill or stationary bicycle. As their heart rate rises, some people develop an alternating pattern, or alternans, in the amplitude of the T wave. Such a propensity to develop T-wave alternans is considered a harbinger of the problem that defibrillators protect against.

Many people meet the current criteria for defibrillator implantation but never get a device. Sometimes, doctors conclude that a device is probably unnecessary; in other cases, patients can't be convinced that they need it. Broader use of T-wave alternans testing might combat both those obstacles by giving doctors and patients additional information, Bigger says.

Ten years after Rosenbaum's initial report on T-wave alternans, Bigger and his colleagues published a report on 177 people whose low ejection fractions and other aspects of their health status qualified them to receive defibrillators. Among the two-thirds who had either T-wave alternans or an ambiguous T-wave pattern, 17.8 percent died within the 2-year study period. By contrast, the 2-year death rate was only 3.8 percent among the group with a normal T-wave pattern.

Rosenbaum says that he and his colleagues have just completed the first clinical trial to use T-wave alternans to guide implantation of defibrillators. He won't yet reveal the results but says that he will present them this November at a meeting of the American Heart Association. Defibrillator manufacturer St. Jude Medical of Saint Paul, Minn., supported the study.

Such studies "will certainly shed important light on the T-wave alternans question," says Michael R. Gold of the Medical University of South Carolina in Charleston. However, he adds, those studies are already somewhat outdated because certain procedures that were standard when the studies began, such as an invasive procedure called electrophysiology testing, have since fallen out of favor.

Some doctors are incorporating T-wave analysis into clinical practice even as they continue to collect experimental data. In a collaborative effort, heart specialists in Cincinnati and Ann Arbor, Mich., evaluated T-wave alternans in 768 consecutive patients whose ejection fractions had fallen, after a heart attack, to 35 or less.

Each doctor in the study decided on a case-by-base basis whether to recommend a defibrillator. Collectively, the investigators implanted the devices in 30 percent of the 254 volunteers who had normal T-wave patterns and in 62 percent of the 514 people with T-wave alternans. The doctors then kept track of the patients for an average of 18 months.

In the May 2 *Journal of the American College of Cardiology*,

ALTERNATING CURRENT — An electrocardiogram's T wave, which reflects the electrical repolarization of the heart's ventricles, can vary in amplitude from one heartbeat to the next (exaggerated here, with difference indicated by green and blue lines). The alternating pattern, or alternans, suggests that a person is susceptible to sudden death from cardiac arrest.

In follow-up research, the investigators analyzed T-wave patterns from 549 participants, including those from the first study and others who appeared to be at slightly lower risk of sudden cardiac death. Overall, only 69 of these volunteers had received a defibrillator.

Afterward, "people who had the normal test had a very low incidence of death or sustained arrhythmias," says Bigger. Within 2 years among those 189 people, one person with a normal T-wave pattern died from an arrhythmia and one died from an unrelated cancer. Two other volunteers in this group survived serious arrhythmias.

But among the 360 volunteers with atypical T-wave alternans, there were 38 deaths and 9 nonfatal arrhythmias within 2 years, Bigger's team reported in the Jan. 17 *Journal of the American College of Cardiology*.

Notably, in the second analysis, the researchers included some volunteers whose ejection fractions were as high as 40—people not currently considered defibrillator candidates.

When T-wave alternans results are normal, comments Rosenbaum, "we're doing the patient a big favor by not implanting a defibrillator." Using the new measure to inform clinical decisions, he and other researchers argue, could prevent thousands of needless procedures in patients who are currently advised to get the devices.

But electrophysiologist Rachel Lampert of the Yale University School of Medicine cautions, "If you're going to narrow that group, you want to be pretty sure that anyone you're excluding is not going to die suddenly." Only a clinical trial rigorously comparing criteria for implants could provide such assurance.

Paul S. Chan of the Veterans Affairs Ann Arbor Healthcare System and his colleagues reported that, other factors being equal, patients with atypical T-wave alternans were 2.3 times as likely to die from arrhythmia as those with normal electrical activity were.

Bigger proposes a two-step method for evaluating patients who might need defibrillators. First, anyone with an ejection fraction of 40 or lower should be tested for T-wave alternans. Making the ejection fraction threshold higher than the current standard of 30 would identify more people who are at risk of arrhythmia, he says.

Then, patients with normal T-wave patterns—presumably about one-third of those who get tested for T-wave alternans—would be discouraged from getting a device. The latter step, says Bigger, would "pull out those who are at such low risk that they'd have very little if any benefit from an ICD."

"T-wave alternans has real merit for keeping people who don't need devices from getting them and convincing people who need them to get them," he says.

NERVOUS ENERGY As promising as the test for T-wave alternans is, it's unlikely to be the final word in predicting cardiac arrest or in assigning defibrillators to patients. Researchers anticipate that adding new tests to cardiac care will make for even better decisions.

"I think T-wave alternans has proven itself," says Verrier. But he adds, "the field is going [toward] what we call the multi-parameter approach."

In that vein, doctors might analyze each patient's ejection frac-

E. ROELL

tion, T-wave pattern, and other factors to calculate "a risk-assessment score for sudden cardiac death," he says. Similar scoring systems exist for heart attack risk and other health threats.

Several of the most promising parameters reflect what electrophysiologist Georg Schmidt calls the "software of the heart," or the organ's responses to the nervous system.

Like T-wave alternans, these parameters can be gleaned from EKG data. Each is calculated by a complex algorithm that analyzes the time intervals between many consecutive heartbeats.

These parameters offer a window into the baroreflex, a biological response to short-lived perturbations in blood pressure. When blood pressure momentarily falls in a healthy person, which is a common and inconsequential occurrence, part of the nervous system instantaneously commands the heart to accelerate as compensation. Over several seconds, the heart rate returns to normal.

In some people, "baroreflex doesn't work very well. A poor baroreflex is a very strong indicator of risk for cardiac mortality," says Schmidt of Technical University Munich in Germany. He and other researchers have studied this dangerous bug in the heart's software by using several measures.

In a 2003 study, for example, Schmidt and his collaborators measured baroreflex over 24 hours by using a marker called heart-rate turbulence. They found that an abnormal baroreflex was linked to death nearly six times as often as was a normal value. An ejection fraction below 30 percent, by comparison, multiplied risk by a factor of only 4.5.

All 1,455 volunteers had had heart attacks before participating in the study, but most didn't qualify for defibrillator implantation under current guidelines. That suggests that the new measure could be used to save lives in people whom current methods don't identify as endangered, Schmidt says.

While the heart's acceleration after a blood pressure drop is one facet of heart-rate turbulence, "the deceleration pattern seems to be more meaningful," Schmidt says.

In subsequent research in 1,256 other volunteers, Schmidt's group confirmed that what it calls deceleration capacity is a powerful predictor of whether a person will die within 2 years. The results appeared in the May 20 *Lancet*.

Doctors might weigh intermediate deceleration-capacity scores along with other relevant factors, including ejection fraction and T-wave alternans, Schmidt says. He argues that people with severely reduced deceleration capacity need a defibrillator, even if their ejection fraction appears normal. But people with normal deceleration capacity and an ejection fraction greater than 30 percent—which would include two-thirds of the study volunteers—need not receive a defibrillator.

> "We're doing the patient a big favor by not implanting a defibrillator."
>
> — DAVID S. ROSENBAUM, CASE WESTERN RESERVE UNIVERSITY

"Deceleration capacity may be an important sudden-death-risk stratifier that will complement T-wave alternans," Verrier comments.

A third measure of nervous system function, called heart-rate variability, is also being examined. For 3 years, Eric Rashba of the University of Maryland at Baltimore and other investigators studied 274 volunteers with low ejection fractions but no past heart attacks. High variability hallmarks a heart that, in spite of its mechanical problems, has relatively little risk of going into arrest, the researchers reported in the March *Heart Rhythm*.

"It makes sense to combine the information from all these tests," Schmidt says. "What we need for all these new risk predictors is studies," he says. "Large trials. Intervention trials."

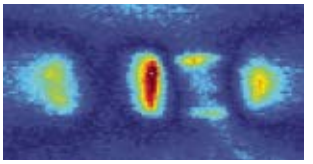
The vanguard of that data wave, says Bigger, may come in November with the results of the pending trial of T-wave alternans as a predictor of heart problems. ■

OF NOTE

TECHNOLOGY

A thin laser gets thinner

Researchers have created a microchip laser that fires an extraordinarily thin beam of high-intensity light. Because the beam can be as narrow as a few tens of nanometers across, it may prove useful for tasks such as writing close-packed data bits onto optical disks and identifying the chemicals making up nanoscale objects, its inventors say.



SHARPER IMAGE Infrared emissions from a prototype microlaser reveal an intense beam (red in center spot) only 40 nanometers across. Some less focused radiation also appears as bright patches.

In the past, experimenters have shone microlaser beams through minute holes to create beams of nanoscale dimensions, notes electrical engineer Kenneth B. Crozier of Harvard University. However, the resulting beams were weak. To overcome this problem, he, Harvard physicist Federico Capasso, and their colleagues have interrupted a beam with a pair of close-spaced, rod-shaped gold patches. Fabricated right where the beam emerges from an infrared microlaser, the patches act jointly as a tiny antenna that focuses the laser light.

Crozier says that the narrowed beam is hundreds of times as intense as comparably thin beams shone through holes. The Harvard team describes its new device in the Aug. 28 *Applied Physics Letters*. —P.W.

ANTHROPOLOGY

Neandertal debate goes south

Neandertals lived on southwestern Europe's Iberian coast until about 24,000 years ago, sharing the area for several thousand years with modern humans before dying out. This new finding indicates that Neandertal extinction occurred surprisingly gradually, at least near the Mediterranean Sea, says a team led by Clive Finlayson of the Gibraltar Museum.

In contrast, many other researchers suspect that Neandertals hit an evolutionary dead end 30,000 years ago, succumbing to competition from *Homo sapiens* who arrived in western Europe 32,000 years ago.

Between 1999 and 2005, Finlayson and his colleagues excavated Gorham's Cave in Gibraltar, located at Spain's southern tip. Radiocarbon dates for pieces of burned wood retrieved among Neandertal stone tools indicate that these human ancestors used part of the cave from 32,000 to 24,000 years ago, the investigators report in a paper published online Sept. 6 for an upcoming *Nature*.

New radiocarbon evidence from other cave sediments, which yielded artifacts typical of modern humans, places *H. sapiens* in the cave starting 19,000 years ago, although they were in the area far earlier. Small groups of Neandertals and modern humans simultaneously inhabited Gibraltar and nearby locales for several millennia but had little contact with each other, the researchers theorize.

Some archaeologists disagree. Because tiny amounts of soil contamination can markedly reduce radiocarbon ages, Finlayson probably overestimated how long Neandertals stayed in Gibraltar, remarks Francesco d'Errico of the University of Bordeaux in France.

H. sapiens material previously excavated from another part of Gorham's Cave dates to 30,000 to 28,000 years ago, a sign that Neandertals and modern humans mingled there, contends João Zilhão of the University of Bristol in England. —B.B.

BIOMEDICINE

Progestin linked to hearing loss in older women

Elderly women who received progestin as part of hormone replacement therapy have poorer hearing than do women who didn't get progestin, a new study finds.

Researchers tested the hearing of 124 women ages 60 to 86. Of these, 30 had received estrogen alone, 32 got combination therapy including estrogen and progestin, and 62 didn't take either hormone. The women who had received hormones took them for 5 to 35 years.

The scientists analyzed the women's hearing in several tests, including one that gauges problems discerning speech amid background noise—a common complaint among elderly people. The women who had received either no hormones or estrogen alone fared significantly better, on average, on all the tests than did those who had received progestin, the researchers report in the Sept. 19 *Proceedings of the National Academy of Sciences*.

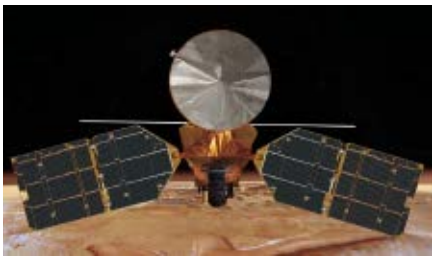
It's unclear how progestin might affect hearing, says study coauthor Robert D. Frisina, a neuroscientist at the University of Rochester Medical Center in New York.

He notes that the combination therapy delivers estrogen and progestin in regular doses every day. "That timing is completely different from normal pregnancy or menstrual cycles," during which the hormone concentrations are elevated some days and not others, Frisina says. —N.S.

PLANETARY SCIENCE

Martian doings

Two Mars vehicles—an orbiting spacecraft and a robot on the planet's surface—have reached new milestones in their missions. Seven months after its arrival, the Mars Reconnaissance Orbiter, NASA's most recent envoy to that planet, has finished reshaping its orbit into the nearly circular, low-altitude path that will give it a close view of the Red Planet. During the maneuvers, flight engineers sent the craft sailing through the upper layers of Mars' atmosphere 426 times, using friction to gradually decrease Orbiter's highest altitude from 45,000 kilometers to 486 km.



MARS MAPPER The Mars Reconnaissance Orbiter, seen in this artist's illustration, arrived at the Red Planet in March and will begin its main mission in November.

During its 2-year study, set to begin in November, Orbiter is expected to return more data about Mars than all previous Mars missions combined. For example, the craft will view the 70-meter-deep crater Victoria and will map the mineral content of that region.

In the meantime, the rover Opportunity, one of the twin field geologists that have explored the planet since January 2003, is approaching the rim of Victoria, the widest and deepest crater that the vehicle has visited. Scientists intend to use Opportunity's

E. CUBUKCU ET AL./APPLIED PHYSICS LETTERS; JPL/NASA

first images of the rim to determine how the rover might descend into the crater. "Victoria has been our destination for more than half the mission," says rover scientist Ray Arvidsen of Washington University in St. Louis. Information about the rocks that are exposed on the crater's walls will provide new information on past conditions, including whether shallow water once covered that area.

While Opportunity rolls along, its twin—Spirit—isn't faring as well during the planet's winter. Its solar batteries have been depleted by low light. Spirit continues to take measurements but since April has remained parked in an outcrop called Low Ridge Haven. —R.C.

BIOMEDICINE

Shingles shot's value is uncertain

The cost-effectiveness of a new vaccine against shingles remains uncertain, according to a new study. So, health policy makers don't have enough information to recommend for or against routine use of the shot, say the researchers.

Shingles, also called herpes zoster, develops when a person previously infected with chickenpox experiences a reactivation of the dormant virus. Nationwide, shingles annually affects 300,000 to 600,000 people. People usually recover within a month, but some later experience flare-ups of severe pain.

Zostavax, a vaccine made by Merck & Co. of Whitehouse Station, N.J., and given to people who haven't had shingles, lessens the incidence and severity of symptoms in people age 60 and older (*SN: 6/4/05, p. 358*). The government approved the vaccine's sale in May, and its list price is about $150.

Recently, physician John Hornberger and analyst Katherine Robertus, both of the research firm Acumen in Burlingame, Calif., used Merck's data on the vaccine's efficacy to calculate cost-effectiveness, which could influence how willing insurers are to pay for the shot.

In the Sept. 5 *Annals of Internal Medicine*, the researchers conclude that the vaccine is more cost-effective in people in their early 60s than in people 80 and older. That's because the younger group's immune response to vaccination is stronger, and longer life expectancy multiplies any benefit, the researchers say.

However, the overall cost-effectiveness is difficult to gauge, Hornberger says. First, researchers have few data to use in attempting to pin a dollar value on people's suffering from shingles. Second, Merck's study ran for just 3 years, so it's unclear how long the vaccine's protection lasts.

Says Hornberger, "If it only lasts 5 years, and then you have to revaccinate, then it certainly isn't cost-effective in any population." —B.H.

PLANETARY SCIENCE

SMART stop

The European Space Agency's first mission to the moon ended with a deliberate bang on Sept. 3. The planned crash of the SMART-1 spacecraft, which had photographed the moon and mapped its mineral and elemental composition from lunar orbit since November 2004, created a flash caught by dozens of telescopes on Earth.

CRASH! Infrared image of the lunar impact (white spot) generated when the SMART-1 spacecraft struck the moon according to plan on Sept. 3.

A newly installed infrared camera on the Canada-France-Hawaii Telescope, located on Hawaii's Mauna Kea, pinpointed the crash and for at least 75 seconds, observed the expansion of the dust cloud generated by the high-speed impact.

This telescope and other ground-based instruments supplied astronomers with the first images from Earth of a lunar impact and its aftermath. Analysis of the dust cloud and its expansion, combined with information on the speed of the craft, may provide new information about the material generated in a lunar crash. —R.C.

TECHNOLOGY

Start your engines

An automotive system designed to reduce toxic hydrocarbon emissions has received the checkered flag from mechanical engineers who examined the device.

Once an engine reaches its operating temperature, catalytic converters eliminate nearly all hydrocarbon emissions. However, in the first 2 minutes after a car is started, some toxic fuel doesn't burn entirely and gets spit out the exhaust pipe. Up to 95 percent of a vehicle's hydrocarbon emissions occur during this warm-up period.

In 2001, a group of engineers developed a lightweight, inexpensive system, called the on-board distillation system, that converts regular fuel into a highly volatile distillate that vaporizes more easily as the engine warms up (*SN: 1/20/01, p. 39*). This start-up fuel is kept in a separate tank that's accessed only during the first 20 seconds after ignition.

Researchers tested this start-up tank by installing it on a Lincoln Navigator and running the vehicle through a drive simulation used by the federal government to determine automotive regulations, says Marcus D. Ashford of the University of Alabama in Tuscaloosa. They found that activating the system decreased the car's hydrocarbon emissions by 81 percent.

Ashford and Ronald D. Matthews of the University of Texas at Austin, who were part of the group that developed the system, report these results in the Sept. 15 *Environmental Science & Technology*.

The technology could be ready for mass production in a few years, but car manufacturers haven't produced the inexpensive system because they are focusing on making better catalytic converters instead of adjusting fuel volatility, Ashford says. —E.J.

BEHAVIOR

Mood disorder cuts work performance

Lost workdays occur especially frequently among people with bipolar disorder, even more so than among workers with major depression, a national survey finds.

Major depression consists of recurrent bouts of helplessness, hopelessness, and depressed mood. In contrast, swings between periods of severe depression and of euphoria characterize bipolar disorder.

Researchers led by sociologist Ronald C. Kessler of Harvard Medical School in Boston interviewed a nationally representative sample of 3,378 workers. The interviews revealed that in the previous year, 1 percent had suffered from bipolar disorder and 6 percent had experienced major depression.

The team counted as lost work time both absences and lowered job performance. Each worker with bipolar disorder lost the equivalent of almost 66 workdays yearly, compared with 27 lost workdays for each person with major depression, the researchers report in the September *American Journal of Psychiatry*. This difference reflected more-severe and longer bouts of depression in people with bipolar disorder, Kessler and his co-investigators conclude.

They advocate studies to determine whether workplace screening and treatment for both mood disorders might reduce lost work time. —B.B.

C. VEILLET ET AL./CFHT

Books

A selection of new and notable books of scientific interest

SUCCESS THROUGH FAILURE: The Paradox of Design

HENRY PETROSKI

The best new designs grow out of failed old designs, writes Petroski. A professor of civil engineering and history, he explores how anticipation and avoidance of failure lie at the core of design of objects from laser pointers to bridges. In the course of daily life, consumers experience and accept minor failures such as the occasionally frozen personal computer. Other failures, such as medicine bottles too easy for children to open, can lead to the abandonment of a product in favor of a new design. Petroski explores the role of testing in the development of designs, stressing that even the most-tested objects aren't immune from failure. He warns that given the ever-present threat of design failure of things large and small, engineers must never be complacent. ***Princeton, 2006, 235 p., b&w images, hardcover, $22.95***.

SOLAR REVOLUTION: The Economic Transformation of the Global Energy Industry

TRAVIS BRADFORD

President of a nonprofit organization for sustainable development, Bradford asserts that solar energy will eventually become the cheapest source of energy because it can flow directly from the source to the consumer. Like the information technology revolution of the past few decades, the solar revolution will invigorate market economies by transforming the way in which we use energy, he says. The cost effectiveness of photovoltaic technology will continue to develop, so that it will appeal to the mass market, not just niche industries. The author looks at energy sources such as nuclear, wind, and biomass and explains why he thinks that solar energy will emerge as the best among these alternatives to fossil fuels. ***MIT Press, 2006, 238 p., b&w illus., hardcover, $24.95***.

QUANTUM ENIGMA: Physics Encounters Consciousness

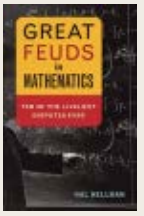
BRUCE ROSENBLUM AND FRED KUTTNER

Quantum theory has become a cornerstone of modern physics. However, the scheme predicts seemingly impossible conditions, such as objects existing in two states at once in the way that Schrödinger's cat is both dead and alive until observed. Such situations establish a connection between physics and consciousness that authors Rosenblum and Kuttner call the quantum enigma. They explain the enigma and the controversy behind it in straightforward, nontechnical language. Physics has long presented hypotheses that are counterintuitive, note the authors. However, quantum theory introduces predictions that even Albert Einstein couldn't accept. Rosenblum and Kuttner, both physics researchers, explain what physicists and philosophers think about these predictions and the implications that they have for the idea of free will and the origins of the universe. ***Oxford, 2006, 211 p., b&w illus., hardcover, $29.95.***

GREAT FEUDS IN MATHEMATICS: Ten of the Liveliest Disputes Ever

HAL HELLMAN

A history of mathematics often reads like a soap opera. Before the days of academic pressure to publish or perish, mathematicians often held their discoveries as personal secrets and vehemently defended their ideas against both plagiarism and criticism. Hellman, author of several popular science books, reveals the details behind some of the greatest feuds in mathematics and the intrigue and betrayal that resulted. Sixteenth-century mathematicians Girolamo Cardano and Niccolò Tartaglia argued over the invention of cubic equations, ending when Tartaglia allegedly turned over Cardano to Spanish inquisitors. Isaac Newton and William Gottfried Leibniz warred over their claims of independently developing calculus. In the early 20th century, David Hilbert and L.E.J. Brouwer argued over the foundations of mathematics in a battle that Albert Einstein described as "the war of the frogs and the mice." Hellman explains these battles. ***Wiley, 2006, 250 p., hardcover, $24.95.***



EXPLORING THE SOLAR SYSTEM: A History with 22 Activities

MARY KAY CARSON

Perhaps even the earliest human beings gazed at the night sky and wondered about the mysteries of space. People first marked the passage of time beyond a single day by noting the movement of stars and planets with the naked eye. Eventually, scientists developed increasingly sophisticated tools and methods for exploring the heavens. Carson, an author of educational children's books, explains how scientists explore the solar system today and how the development of telescopes, rockets, satellites, and other technologies have led to great discoveries about other stars and planets. Galileo Galilei's invention of the telescope enabled him to observe the orbits of planets around the sun. William Herschel's development of more-powerful telescopes led to his discovery of Uranus, two moons of Saturn, and more than 2,500 stars. Carson explains the foundations of rocket science and the moon landings. She tells how the development of space probes led to the mapping of Mars and Venus. Throughout the book are hands-on activities that prompt young readers to study the solar system. The book ends with a field guide to the solar system that lists important facts and figures about each planet and the sun, along with time lines of important dates in space exploration. For ages 9 and up. ***Chicago Review Press, 2006, 168 p., b&w and color images, paperback, $17.95.***

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LETTERS

Moo juiced?

I live in Northern California, where forest-biomass power plants are common ("Radiation Redux: Forest fives remobilize fallout from bomb tests," *SN: 7/15/06, p. 38*). One power plant takes the ashes that result and places them where cows forage. I'm wondering to what level of concentration this process will accumulate the cesium in organic dairy products.

JESSE NOELL, EUREKA, CALIF.

The amount of radioactive cesium-137 taken up by trees is small, and the amount taken up by grass fertilized with ash from those trees would be even smaller, says geochemist Mark Fuhrmann of the Brookhaven National Laboratory in Upton, N.Y. —S. PERKINS

Hidden meaning

Scientists seek environments that are weightless, near-perfect vacuums in which to conduct experiments. If genuine cloaking were achieved ("Out of Sight: Physicists get serious about invisibility shields," *SN: 7/15/06, p. 42*), I would expect there would be a host of experiments that might be conducted in "perfect darkness"—environments free of various energy wavelengths.

BERNARD RICE, HINSDALE, ILL.

Cause, effect, or neither?

I was surprised to see in *Science News*, conclusions about causation made on the basis of correlational research ("Keep on Going: Busy seniors live longer, more proof that it pays to stay active," *SN: 7/15/06, p. 37*). The variance in activity levels may have been a consequence of differing levels of energy among the participants at the outset of the study, perhaps due to differences in general health. We should be careful about this victim-blaming habit.

JOAN SOPHIE, CHICAGO, ILL.

Perhaps the more sedentary people in the study had underlying medical problems that caused them to lack energy and to die earlier than the active people. In an effort to address that issue, the study authors accounted for many factors, such as body fat, race, heart disease, diabetes, cancer, and smoking status, in the study participants. —N. SEPPA

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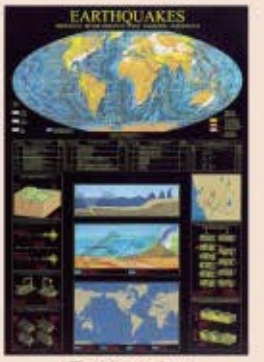

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This science poster defines fault line locations and describes the shifting of tectonic plates, plus much more! Size: 26.25" X 38.5" Laminated Order # JPT-quakes, Cost: $15.95

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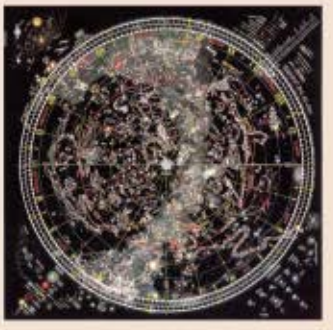
This poster is an ideal picture of one of the greatest forces in nature. Goes great in any classroom with the lightning poster shown above. Size: 24" X 36", Laminated Order # JPT-tornado, Cost: $15.95

Crocodiles and Alligators - Shown adjacent to each type with a globe where each is found. Size: 26 1/2" X 38 1/2", Laminated Order #1652, Cost: $15.95



Map of the Universe - (Northern Hemisphere) Comes with 12-page booklet/ Glows in the dark/ Size 36" X 36" Order #JPT-1884, Cost: $21.95

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