SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

JANUARY 7, 2006 PAGES 1-16 VOL. 169, NO. 1

night light on cancer

footprints of the stone age

busy brain begets alzheimer's

poison kills zebra mussels

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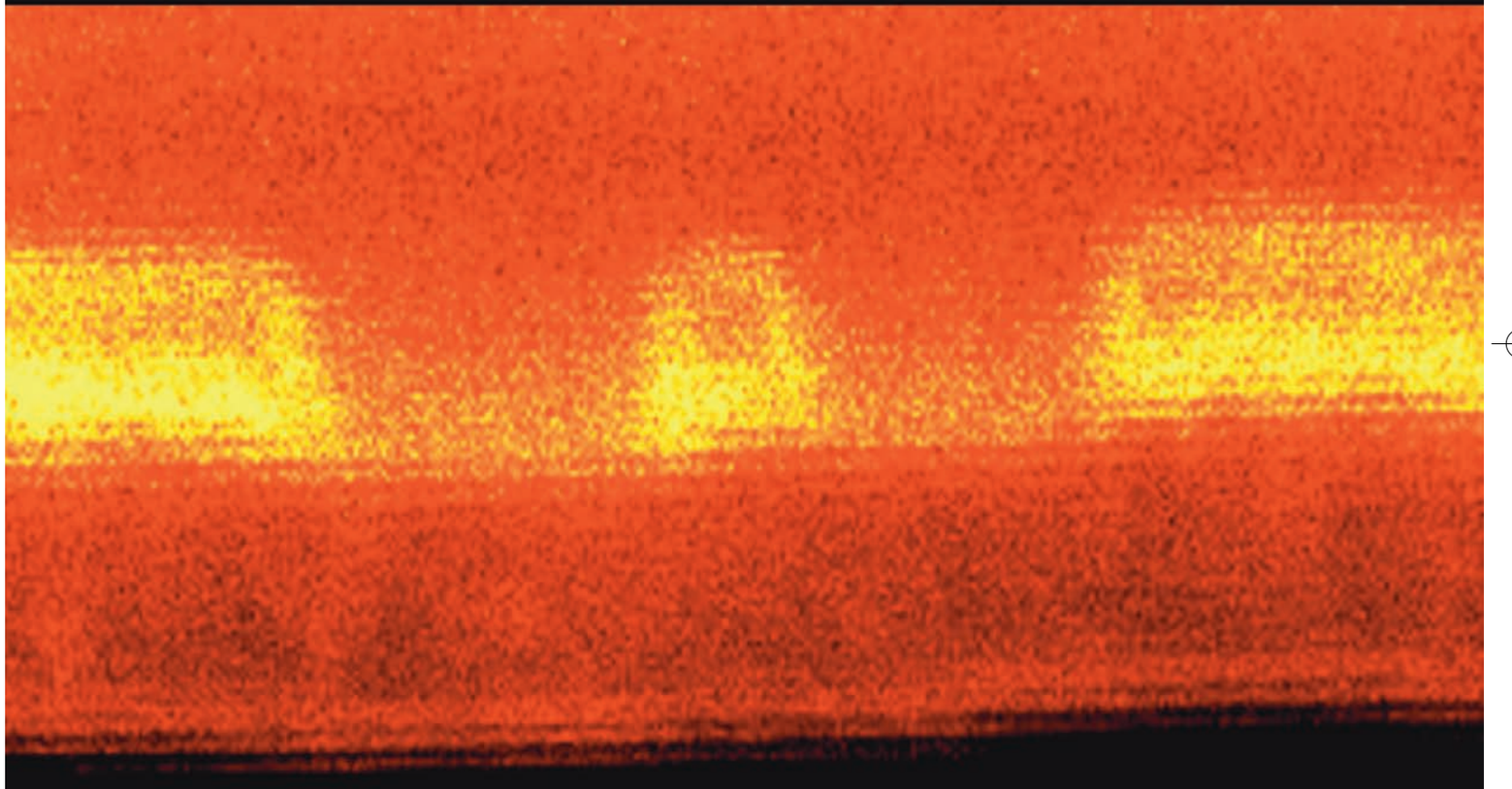

magnetic duet

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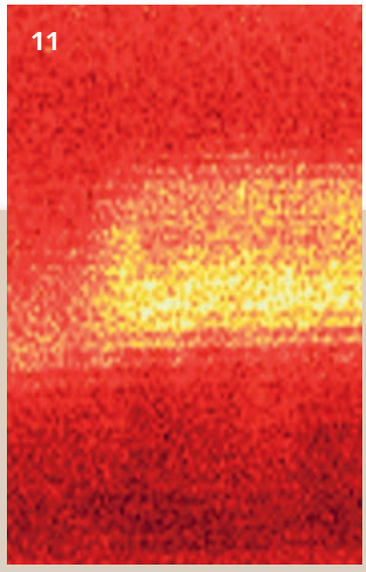

Features

This Week

Of Note

Departments

Cover Big advances in computer memory, radar, and wireless communications may result from surprising new findings about microscopic magnets. Electrons streaming through nanoscale stacks of metals force the orientations of magnetic layers to flip or twirl. A pair of such nanostructures (gaps in the yellow bar of this false-color electron micrograph) can act as a microwave generator whose signals spontaneously synchronize in the same way that fireflies' blinking and other natural phenomena do. (Freescale Semiconductor) Page 11

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SCIENCE NEWS
This Week

Stone Age Footwork

Ancient human prints turn up down under

Researchers working near the shore of a dried-up lake basin in southeastern Australia have taken a giant leap backward in time. They've uncovered the largest known collection of Stone Age human footprints.

The 124-or-more human-foot impressions, as well as a few prints left by kangaroos and other animals, originated between 23,000 and 19,000 years ago in a then-muddy layer of silt and clay, say archaeologist Steve Webb of Australia's Bond University in Robina and his colleagues. Their report appears in the January *Journal of Human Evolution*.

The discoveries, which lie in an area consisting of 19 ancient lake basins known as the Willandra Lakes system, provide a unique look at the behavior and physical capabilities of late Stone Age people, notes geologist and study coauthor Matthew L. Cupper of the University of Melbourne.

An aboriginal woman found the footprints in August 2003 while assisting Webb in an archaeological survey of the area. Webb and his coworkers determined that erosion had exposed 89 footprints. The researchers then dug through soil to find another 35 footprints.

To estimate age, the team shone a laser light on sand grains from sediment just above and below the footprint-bearing soil layer. Light emitted in response provided a measure of accumulated radioactivity, from which the group calculated the sediments' ages.

Intriguingly, 76 footprints belong to the tracks of eight individuals of different sizes and ages. The foot sizes and stride lengths, in comparison with those of modern aborigines, indicate that six relatively large adults ran in the same direction across the muddy plain. Two of them exceeded 6 feet in height. Another two people, a teenager and a child, walked in the same general direction.

"It's possible that these people were venturing between the shores of the two nearest large lakes," Cupper says. "Maybe they were moving from one temporary camp to another, or perhaps they were on a hunting or fishing expedition."

Whatever these Stone Age folk were doing, the largest of them achieved a running speed of perhaps 12 miles per hour, comparable to that of a fit recreational runner today, Cupper says. The researchers made that calculation by comparing the stride lengths of the prehistoric adult with comparable data from modern distance runners of similar height.

Circular indentations, no more than 2 inches across, appear irregularly in the soil near the human footprints. Some type of weapon or a staff could have produced these marks, Cupper suggests. Shallow grooves that extend for as many as 15 feet in some areas suggest that poles were dragged across the ground, he adds.

Earlier fossil and stone-tool finds indicate that people inhabited southeastern Australia by around 40,000 years ago, notes anthropologist Peter Brown of the University of New England in Armidale, Australia. Still, he cautions, ages assigned to the newly discovered footprints need to be verified by independent teams.

Brown says, "The most remarkable thing about the Willandra Lakes footprints is that they are preserved at all." —B. BOWER

CUPPER, WASHINGTON UNIV., ST. LOUIS

SOLE SURVIVAL **Footprints attributed to a Stone Age person disappear under an Australian dune (top). In an impression of an adult's right foot (inset), the toes stand out.**

Alzheimer Clue

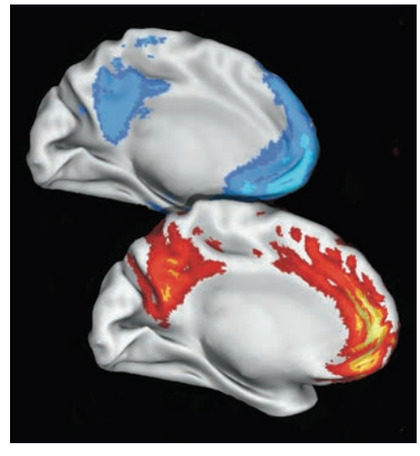
Busy brain connections may have downside

Brain areas that are chronically activated produce increased amounts of amyloid beta, the waxy protein implicated in Alzheimer's disease, a study in mice shows.

The work comes on the heels of a report, released 5 months ago, showing that brain areas switched on during daydreaming in young, healthy adults are largely the same spots found to be damaged in Alzheimer's patients. Combined, the studies suggest that steady activity in certain parts of the brain can contribute to the disease.

In the new study, scientists used electrical stimulation and injections of chemicals to either stimulate or turn off neurons, the primary brain cells, in mice. When activated neurons fire messages across synapses to other neurons, the chemical building blocks for amyloid beta are released into the fluid that fills the spaces among neurons in the brain. That's where amyloid beta forms into plaques in Alzheimer's patients.

In the mice, chronic stimulation of specific parts of the brain correlated with increased release of the building block chemicals, whereas less-frequent stimulation led to decreased release of them. David M. Holtzman, a neurologist at Washington University in St. Louis, and his colleagues report these findings in the Dec. 22, 2005 *Neuron*.



BRAIN DRAIN **Brain areas active during daydreaming in young, healthy people (blue image) are similar to those spots damaged in Alzheimer's patients (red image), suggesting that steady stimulation of certain areas contributes to the disease.**

"This study provides important new data [connecting] neuronal activity and control of extracellular amyloid-beta levels," says Roberto Malinow, a neuroscientist at Cold Spring Harbor (N.Y.) Laboratory.

The earlier study in people suggested specific brain areas that might benefit from some downtime.

In the Aug. 24, 2005 *Journal of Neuroscience*, neuroscientist Randy L. Buckner and his colleagues at Washington University compared magnetic resonance images of the brains of Alzheimer's patients with images of the brains of healthy young peo-

ple. A striking correlation emerged between areas damaged in Alzheimer's patients and regions activated during daydreaming and idle thought in the younger people. In the young people, some of these regions were also used in memory retrieval, suggesting that a lifetime of increased activity in those regions predisposes a person to poor recall.

"The data we saw ... didn't provide a plausible biological mechanism for how the brain could regulate amyloid-beta levels," says Buckner, a Howard Hughes Medical Institute investigator now at Harvard University. "This [new] paper shows a way in which brain activity might regulate amyloid beta production."

The research doesn't necessarily contradict evidence that mentally strenuous activities such as reading or solving puzzles can protect against the disease (*SN: 3/10/01, p. 148*). Some research hints that such tasks, while revving up certain areas of the brain, shut down others that are prone to amyloid-beta accumulation, says Holtzman.

Many puzzles remain. For example, Malinow says, the cerebellum is a busy area of the brain, yet it is seldom affected in Alzheimer's patients. "I don't know if neuronal activity can be the only determinant," he says.

Holtzman agrees that Alzheimer's risk is probably influenced by other factors, including genetic and environmental pressures. But if scientists can establish that chronic activity in some areas of the brain contributes to Alzheimer's disease, it might open the way for drug treatments that lessen that stimulation, says Holtzman. "By regulating some [brain] areas, you might affect the disease."

Treatments for Alzheimer's are sorely lacking (*SN: 5/8/04, p. 296*). The disease afflicts roughly 24 million people worldwide. The total could soar to 81 million by 2040, researchers report in the Dec. 17, 2005 *Lancet*. —N. SEPPA

Gunning for the Gut

Tiny particles might fight invasive zebra mussels

By modifying a method used to flavor foods, researchers have made a substance that poisons the zebra mussel. That invasive species clogs water pipes that feed power plants and other facilities.

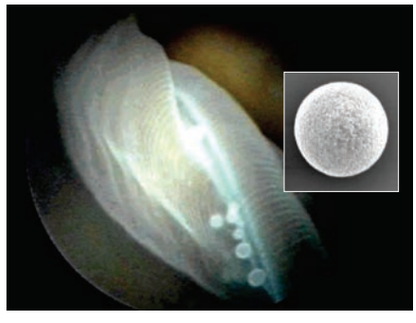
Around the Great Lakes and along much of the Mississippi watershed, facility operators lose about $1 billion each year to the mussel. They fight it with various toxicants, including chlorine and potassium salts.

Each mussel defense faces a test. "Either it's got to be toxic to zebra mussels and innocuous to other organisms, or you need to remove it or inactivate it" before it enters the environment, says Charles R. O'Neill of the New York Sea Grant at Cornell University, who studies aquatic invasive species.

Furthermore, he says, when zebra mussels detect a toxicant, they sometimes stop filtering water for days or weeks while the chemical dissipates.

Scientists at the University of Cambridge in England set out to make a substance that mussels would take in without recognizing as poison and that would be unlikely to harm other creatures. Some funding came from BioBullets Ltd., a London company founded by David C. Aldridge and Geoff D. Moggridge, two of the researchers.

The scientists produced and tested the new substance with assistance from TasteTech Ltd. of Bristol, England, which manufactures commercial food flavorings.



GILL KILL Microscopic particles (inset shows one) containing potassium chloride are toxic to zebra mussels. The photograph depicts such particles moving through a mussel's gill.

To make the mussel poison, TasteTech mixed potassium chloride with hydrogenated vegetable oil and a soaplike surfactant that "encourages the fat to coat the potassium chloride," says Moggridge. When sprayed into a chamber of cool air, the mixture solidified into spherical droplets with typical diameters between 45 and 165 micrometers.

In tests in water spiked with the spheres, zebra mussels took them in and retained some in their bodies, as if they were food particles worth digesting. About 60 percent of mussels died when exposed to the spiked water for 12 hours, Aldridge, Moggridge, and Paul Elliott report in an upcoming *Environmental Science & Technology*. The same concentration of potassium chloride added directly to the water, along with inert spheres, caused few if any deaths.

Disguising the toxicant as food, so that mussels won't reject it, is a good strategy, O'Neill says. "I've never seen anyone try this approach before," he says.

Biologist Robert F. McMahon of the University of Texas at Arlington says, "Zebra mussels take this stuff out the water column and concentrate it in their digestive systems to levels that are toxic." Aquatic organisms that don't filter feed, as mussels do, would take in only inconsequential amounts of the toxicant, he adds.

Long-term consequences for species other than zebra mussels should be minimal because after 2 hours in water, most of the particles fell apart, denuding the remaining potassium chloride, Moggridge says. —B. HARDER

Molecular Car Park

Material packs in carbon dioxide

A crystalline material composed of metal and organic building blocks holds more carbon dioxide than other porous substances do, chemists report. The discovery could lead to a device that reduces power plant emissions of this greenhouse gas.

About 40 percent of the carbon dioxide released in the United States in 2003 came from electric power plants, according to the Department of Energy. A potential strategy for reducing emissions is to fit plant flues with materials that capture the gas from exhaust.

Metal-organic frameworks had previously stored hydrogen (*SN: 6/14/03, p. 382*). In the new study, Omar M. Yaghi and Andrew R. Millward of the University of Michigan in Ann Arbor measured the adsorption of carbon dioxide by nine different frameworks, each composed of organic compounds and either zinc or copper.

The researchers exposed each framework to increasing amounts of carbon dioxide gas in a closed system at room temperature. A framework containing zinc swallowed the largest amount of carbon dioxide—33.5 millimoles of gas per gram of material, or 1.4 times its own weight. The structure has a surface area of 4.5 square kilometers per gram.

The frameworks excel at containing carbon dioxide, says Yaghi, because they can "bring the gas molecules close to each other, like cars in a car park." The gas molecules repel one another, but the attraction between the gas molecules and the metal-organic framework is stronger than the repulsive force. So, in the pores of the material, the gas occupies a smaller volume then it would alone, Yaghi says.

A container filled with the winning framework can take up nine times as much carbon dioxide as the empty container would and twice as much as a container filled with a

ALDRIDGE ET AL./ENV. SCI. & TECH.

carbon-based material previously tested for carbon dioxide storage. The researchers report these results in the Dec. 28, 2005 *Journal of the American Chemical Society*.

The researchers are now working with engineers to scale up the technology and study its effectiveness in flues. They envision a power plant column housing tons of the framework.

The material is reusable because in the absence of the high pressures found in the flue exhaust, the carbon dioxide freely leaves the material. Gas captured from the exhaust might be used to manufacture polymers or incorporated into other industrial materials, says Yaghi.

"It's an interesting piece of work," says Mark Thomas of the University of Newcastle upon Tyne in England. However, he's not yet convinced that the technology is economically feasible. —A. CUNNINGHAM

Locust Upset

DNA puts swarmer's origin in Africa

The desert locust, often blamed for modern crop ruin and biblical plagues, was not an ancient export from the Americas, say DNA analysts.

Some biologists had recently argued that Africa's storied locust arose from ancestors of today's New World *Schistocerca* species that crossed the Atlantic Ocean. That's backwards, Nathan R. Lovejoy of the University of Toronto at Scarborough now says.

Lovejoy and his colleagues used DNA sequences as the basis for a new family tree of the *Schistocerca* genus. Their analysis of that tree suggests that ancient locusts from Africa gave rise to the 50-or-so modern New World species, Lovejoy and his colleagues say in an upcoming *Proceedings of the Royal Society B*. They propose that the African locusts crossed the Atlantic several million years ago.

"We were surprised," says Lovejoy.

The term *locust* refers to grasshoppers that gather in swarms to feed. One of the most famous, the desert locust (*Schistocerca gregaria*) of Africa, can take either of two forms depending on environmental conditions. The mild-mannered green grasshoppers forage individually, but as food and water become abundant, the next generation turns black and yellow. Its members congregate into groups that can include more than a billion. These swarms can fly 100 kilometers in a day.

In 1988, biologists observed a swarm of desert locusts from Africa arrive at the coast of South America. This confirmation of extremely long-distance travel ignited interest in which direction the insects' ancestors had moved.

In 2004, Hojun Song of Ohio State University in Columbus argued that New World locusts had traveled to Africa. He based his claim on a family tree constructed with body characteristics of *Schistocerca* locusts. According to that tree, Song says, the desert locust seems the closest relative only to some recent New World species. Thus, he argued that species were diversifying in the New World when some of them crossed the Atlantic and gave rise to today's African desert locust.

For the new family tree, Lovejoy and his colleagues analyzed a DNA stretch that covered several genes from various species' mitochondria, or cell powerhouses. On the resulting family tree, the African desert locust forms the lowest branch and so represents the most-ancient lineage, says Lovejoy. That pattern argues that ancestors of the desert locust crossed the Atlantic to give rise to a lineage that branched out in the New World, he says.

Song, so far, is sticking to the view that desert locusts migrated out of the Americas. The new family tree, he says, doesn't include as many locust species as the old ones did. Only a family tree based on both morphological data and sequences from more genes will settle the debate, he says. —S. MILIUS

G. SWORD; D. STICK/UNIV. MICHIGAN; STICK ET AL./NATURE PHYSICS

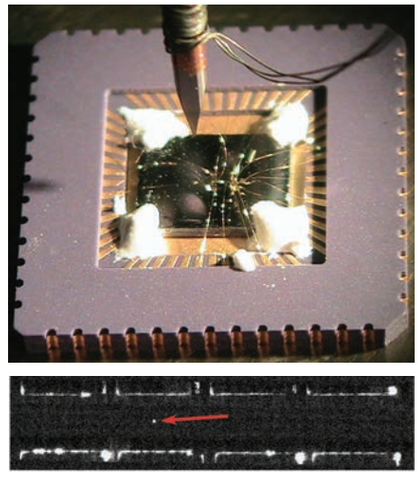
JEKYLL AND HYDE The African desert locust in its solitary green form does little damage, but when it's black and yellow, far-flying swarms can bring crop damage of biblical proportions.

Quantum Chip

Device handles ions as if they were data

Physicists have created a microchip that can hold an electrically charged atom and move it back and forth within a narrow channel. These manipulations lay the groundwork for using trapped ions as data bits in computer chips, the developers of the new device say.

The scientists created the chip as a step toward a new breed of computers, called quantum computers, which represent information using quantum properties of particles (*SN: 7/17/04, p. 46*). Those potentially mighty, yet currently rudimentary, machines are expected to efficiently handle calculations—for instance, breaking encryption codes used for Internet transactions—that would take conventional computers a billion years.



ION INSIDE The black chip (top) within this purple-and-gold holder fulfills a quantum-information–processing goal by trapping and manipulating an ion. A tip installs electrical connections between the chip and holder. In a micrograph, a trapped, fluorescent cadmium ion (bottom, arrow) hovers between rows of electrodes (white line segments).

Led by Christopher R. Monroe of the University of Michigan in Ann Arbor, the new chip's makers also propose additional uses of their device. With further development, it might serve as a component of minuscule atomic clocks (*SN: 9/4/04, p. 150*) or of tiny mass spectrometers, which identify substances by ionizing and measuring fragments of their molecules (*SN: 6/12/04, p. 373*).

The team unveils the chip, which operates in a vacuum at room temperature, in the January *Nature Physics*.

"This will be a great stepping-stone," comments atomic physicist Jörg Schmiedmayer of the University of Heidelberg in Germany. "Miniaturization is, in my opinion, the best way to extend ion trapping."

Since the 1950s, physicists have machined and assembled larger containers to hold just a few ions for such purposes as studying fundamental physics and creating atomic clocks. More recently, researchers have trained lasers on eight trapped ions to tune the particles' quantum states in ways needed for computing.

Traps on chips are the way to go to create quantum computers, says Monroe. Traps will need to be smaller than the machined ones to confine ions tightly, so as to maintain their collective quantum states and to speed their interactions. Practical quantum computers will require manipulations of a few dozen to a million or so ions in close proximity, Monroe says.

On chips, the ion-trap designs could be easily repeated to handle more particles, Monroe says.

Miniaturization onto chips has already played a role in the manipulation of neutral atoms (*SN: 6/17/00, p. 399*). However, notes Schmiedmayer, a pioneer of the neutral-atom chip, that technology differs from what's required for handling ions.

To build the new ion device, Monroe and his colleagues used conventional microchip-fabrication methods to first deposit layers of the semiconductor compounds gallium arsenide and aluminum gallium arsenide onto a gallium arsenide wafer. The scientists next etched away portions of the wafer and the overlying layers to create a gap that's wide at the bottom of the structure, permitting laser-beam access, but only 60 micrometers across at the top.

Flanking this topmost channel are rows of electrodes that generate electric fields to suspend ions and shuttle them along the channel.

Although the devices made so far can store and move only one cadmium ion at a time, the route is now open to chips containing more ions, Monroe says. With those, he adds, scientists will probably duplicate and then surpass the feats of quantum manipulation already attained with conventional ion traps. —P. WEISS

Gauging Star Birth

Spacecraft uses gamma rays as stellar tracer

By detecting the radioactive remains of material hurled into space by dying stars, astronomers have estimated that, on average, our galaxy churns out seven new stars each year.

The researchers used the European Space Agency's INTEGRAL spacecraft to record gamma-ray light, which is high-energy radiation undetectable from Earth's surface. They collected the particular wavelength that arises from the radioactive decay of aluminum-26. The distribution of this aluminum isotope traces the location of dead massive stars in the Milky Way. These stellar heavyweights forge nearly all the galaxy's aluminum, which they expel when they die in explosions known as supernovas.

STAR HUNTER The INTEGRAL spacecraft records gamma rays from the material expelled by exploded stars.

The INTEGRAL team, led by Roland Diehl of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, confirmed that aluminum-26 is found primarily in star-forming regions of the galaxy. In the Jan. 5 *Nature*, the researchers conclude that over the past few million years, an average of two massive stars per century have died as supernovas in the galaxy.

Using theoretical models of the number of massive stars in relation to the total number of stars in the Milky Way, the team also calculated that seven new stars appear each year and that their total mass is about four times that of the sun.

That star-formation rate agrees with those derived from other methods of estimating star birth, notes study coauthor Dieter Hartmann of Clemson University in South Carolina.

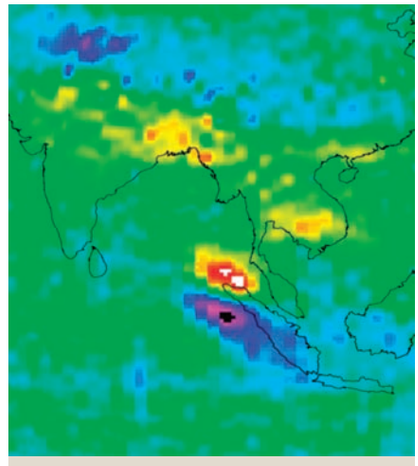
Determining star-formation rates in the Milky Way galaxy is a tricky business, he adds. Astronomers have previously used visible and ultraviolet light emitted by newborn stars. However, such radiation is obscured by gas and dust clouds that tend to concentrate in the Milky Way's spiral arms, where most new stars form. In contrast, gamma rays easily penetrate these clouds.

Aluminum-26's relatively long half-life of 750,000 years also aided in the new estimate, says Hartmann. That longevity enabled INTEGRAL to record the emissions from stars that perished during the past several million years.

Diehl and other researchers had previously constructed maps of the galaxy's aluminum-26 by using less-sensitive instruments, such as a detector on the now-defunct Compton Gamma Ray Observatory (*SN: 1/25/92, p. 53*). But in those older maps, researchers were concerned that a significant amount of the gamma-ray emission might be coming from the sun's neighborhood or star formation at a few localized sources rather than from throughout the galaxy.

The spectrometer on INTEGRAL, launched in 2002, has a critical advantage over previous detectors. It's sensitive enough to record a variety of tiny shifts in the wavelength of gamma-ray light that arise from the rotation of objects spread across the Milky Way.

The shift "is telling us that the aluminum-26 is almost certainly associated with the [entire] galaxy," rather than just a few locations within it, according to James Kurfess of the Naval Research Laboratory in Washington, D.C. The new map therefore validates the use of aluminum-26 as a highly precise gauge of the recent history of supernovas and star birth in the Milky Way, he adds. —R. COWEN



ESA; NASA/JPL/UNIV. TEXAS CENTER FOR SPACE RESEARCH

Mass movement

Earth's gravitational field changed measurably in response to the December 2004 tsunami-spawning earthquake west of Sumatra. The Gravity Recovery and Climate Experiment (GRACE) mission's satellites noted changes associated with the temblor—the first such feat, says Byron D. Tapley, director of the Center for Space Research at the University of Texas at Austin. GRACE's data depict an area—southwest of the quake's epicenter—where Earth's gravity decreased slightly (lower patch of dark blue and purple) and a region northeast of the rupture where gravity increased somewhat (lowest red and yellow patch). Other changes in the image, released by NASA on Dec. 20, 2005, probably reflect movements of water and weather systems unrelated to the quake, says Tapley. —S. PERKINS

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BRIGHT LIGHTS, BIG CANCER

Melatonin-depleted blood spurs tumor growth

BY BEN HARDER

In late 1987, Richard G. Stevens, then at Pacific Northwest Laboratories in Richland, Wash., typed up a short letter and mailed it to Walter Willett at Harvard Medical School in Boston. The two epidemiologists had met just once, and Stevens wasn't confident that his 209-word note, or the suggestion that it contained about a possible contributor to breast cancer, would inspire any action.

But Willett took the suggestion seriously. He and his colleagues began a study that only they could do. They run the Nurses' Health Study, a project unrivaled in scope and duration that tracks how women's health relates to diet, activity, and other factors.

Several years later, members of Willett's team reported that women who frequently work night shifts seem predisposed to develop breast cancer.

It was just as Stevens had suspected. He had hypothesized that nighttime illumination, by interrupting the body's mainly nocturnal production of the hormone melatonin, might increase the risk of breast cancer. Animal experiments and surveys of people over the past 2 decades supported that hypothesis without proving it, says Stevens, currently at the University of Connecticut Health Center in Farmington.

"Now, a watershed study has provided the first strong experimental support," Stevens says.

A woman's blood provides better sustenance for breast cancer just after she's been exposed to bright light than when she's been in steady darkness, researchers led by David E. Blask of the Bassett Research Institute in Cooperstown, N.Y., report.

"Light at night is now clearly a risk factor for breast cancer," Blask says. "Breast tumors are awake during the day, and melatonin puts them to sleep at night." Add artificial light to the night environment, and "cancer cells become insomniacs," he says.

"Sleep per se is not important for melatonin," says Russel J. Reiter, a neuroendocrinologist at the University of Texas Health Science Center in San Antonio. "But darkness is."

The new study has far-reaching implications, says Reiter. First, it could spawn trials that test whether malignancies can be slowed down by altering a person's light environment or by using melatonin supplements. Second, he says, similar studies could show whether exposure to nocturnal light poses a prostate cancer risk to men, as some researchers suspect, or promotes other cancers previously linked to light at night (*SN: 8/28/04, p. 141*).

WHEN CANCER AWAKENS Melatonin forms in the pineal gland, located in the brain, and circulates in the bloodstream. Blood concentrations of the hormone rise after dark from low daytime values and usually peak in the middle of the night.

Because the pineal gland responds to signals transmitted by the optic nerves, bombarding a person's eyes with bright light during the night can erase the usual nocturnal surge and lower the overall melatonin production for the day. That observation concerned researchers, in part because melatonin has slowed breast cancer growth in lab experiments.

Then, there's the disturbing circumstantial evidence.

"Breast cancer is epidemic in the world. It's increasing everywhere," says Stevens. It's most prevalent in industrialized countries, where electric lights are widely used, he says. "It's increasing very rapidly in places that are industrializing," he adds.

Furthermore, compared with other workingwomen, female night-shift workers have about a 50 percent greater risk of developing breast cancer, says William Hrushesky of Dorn Veterans Affairs Medical Center in Columbia, S.C.

Blind women, by contrast, have unusually low rates of breast cancer and high average melatonin concentrations, he says.

"Almost nobody who does shift work adapts to it," Stevens says. On their days off, most shift workers concentrate their activities during daylight, which upsets their circadian rhythms as much as commuting across several time zones would, he says.

> "Breast tumors are awake during the day, and melatonin puts them to sleep at night."
>
> — DAVID E. BLASK, BASSETT RESEARCH INSTITUTE

That presumably explains why the original Harvard study of nurses, which was led by Willett's colleague Eva S. Schernhammer, found that shift workers had an elevated risk of breast cancer (*SN: 11/17/01, p. 317*).

More recently, Schernhammer and her Harvard colleague Susan E. Hankinson found that women who happen to have above-average melatonin concentrations are relatively unlikely to develop breast cancer.

The Harvard researchers estimated nurses' peak nightly melatonin concentrations by measuring the hormone in the first urine void of a day. "Those with higher levels seem to have lower breast cancer risk," Schernhammer says. She and Hankinson reported the data in the July 20, 2005 *Journal of the National Cancer Institute.*

An earlier study didn't find the same statistical relationship, but it had involved melatonin measurements in urine samples taken later in the day. Such samples are less likely to correlate with nocturnal hormone concentrations, says Schernhammer.

She notes that light is not the only relevant factor. Age and obesity both reduce a person's melatonin production, and heavy smoking may do the same, she says. She and other researchers will report the first data that support the smoking-melatonin relationship in an upcoming *Journal of Pineal Research*.

Breast cancer is less common in women who sleep more than 9 hours per night than in women who sleep less, Stevens and six colleagues in Finland report in the Oct. 15, 2005 *Cancer Research*. They compared cancer incidence in 12,222 Finnish women whose average nightly sleep duration had been recorded in 1975 and 1981. By 1996, 242 of the women had developed breast tumors.

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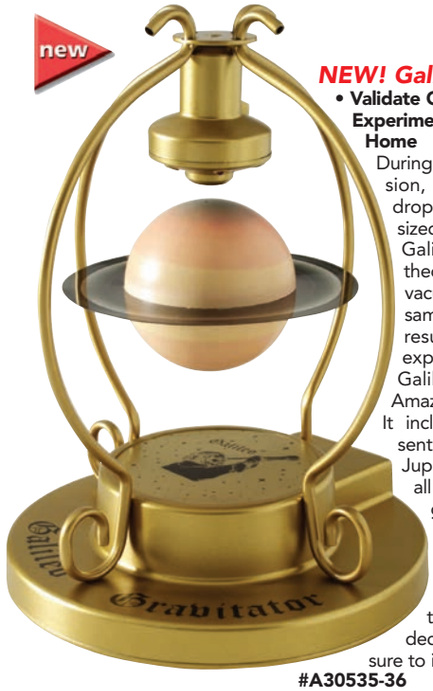

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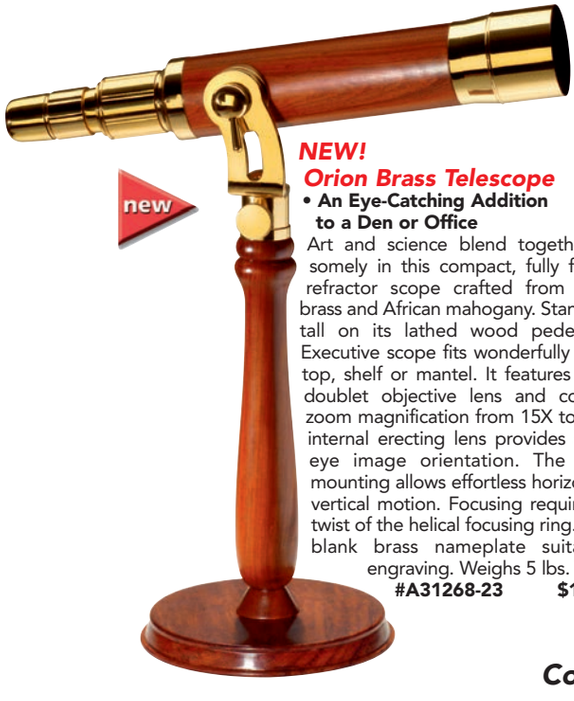

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Women who consistently slept 9 or more hours per night had less than one-third the risk of developing a breast tumor than women who slept 7 or 8 hours per night.

Now, Blask and his collaborators at several institutions have pushed beyond studies finding correlations among cancer, light, and melatonin. At Thomas Jefferson University in Philadelphia, researchers led by George C. Brainard asked each of a dozen healthy female medical students to give three blood samples, one during the day and two at night.

The first nighttime blood draw occurred at 2 a.m., after each woman had been in complete darkness for 2 hours. Then the volunteers stared at a brightly lit, white wall for 90 minutes, and the second nighttime draw took place at 3:30 a.m.

As expected, blood from the 2 a.m. samples contained the highest concentrations of melatonin, and daytime blood contained the lowest. Brainard then sent the samples to Blask for an unusual test of their effect on human-cancer cells.

THIS WAY TO CANCER — Just after exposure to bright nighttime illumination (top), woman produces blood (left) that contains little melatonin and stimulates the growth of a human-breast tumor that has been implanted in a rat (right).

In Cooperstown, Blask and his colleagues had implanted human breast tumor into rats in such a way that a single artery fed a tumor and a single vein received all blood leaving the cancerous tissue. The team then put plastic tubes into the two vessels, creating external conduits to and from the tumor. The researchers also shut the cancerous tissue off from the rest of the rat's circulatory system.

Next, they pumped each blood sample from the Philadelphia medical students into a separate rat's arterial tube and collected the liquid as it came out of the cancerous human tissue. By comparing what blood components went in and what came out, the researchers assessed the tumors' responses to the concentrations of melatonin in the samples. For example, they measured the tumors' uptake of H3-thymidine, an ingredient of DNA that reflects cell division and replication in a tumor.

The results indicated that the tumor cells divided most rapidly when supplied by blood taken from women either in daylight or at night after exposure to the bright artificial light. Those blood samples had low melatonin concentrations. Spiking the samples with synthetic melatonin removed their capacity to promote cancer.

Moreover, melatonin-rich blood from women who had been in darkness spurred cell division only when the researchers added a chemical that blocks melatonin's biological activity.

In further experiments, Blask's team determined that melatonin blocks cancer cells' metabolism of linoleic acid, a polyunsaturated fat that's abundant in food. The same team had previously shown that 13-hydroxyoctadecadienoic acid, the product of linoleic acid metabolism, spurs cancer cells to divide.

The team reports its results in the Dec. 1, 2005 *Cancer Research*.

The unusual test in the rats shows "close to conclusively" that light-induced suppression of melatonin promotes breast-tumor growth, says Schernhammer.

Stevens adds that Blask's new technique of testing people's blood on human tumors in animals is a powerful tool for evaluating the effect of all sorts of actions. Eating a particular food or inhaling a pollutant, for example, could alter the blood concentrations of substances that promote or fight cancer.

MANAGING MELATONIN In the United States, synthetic melatonin is sold over the counter as a dietary supplement. Blask and other researchers want to see tests to assess whether the hormone in this form can ward off breast cancer in women. But they warn that it would be premature for people to take the hormone for that purpose.

"I personally would be pretty cautious about taking over-the-counter melatonin supplements," says Scott Davis, an epidemiologist at the University of Washington in Seattle. "Melatonin supplements are not regulated" the way drugs are, he notes. "There may be all kinds of impurities and contaminants."

Although synthetic melatonin hasn't been shown to be dangerous, it could have adverse effects on the production of reproductive hormones, cautions Schernhammer.

Hrushesky is currently testing the possible benefits of melatonin supplements in men who have undergone surgery for prostate cancer. For now, though, he encourages people to opt for commonsense measures to ensure they get nightly melatonin spikes. Those precautions include going to sleep in the dark at a consistent time each night, exercising regularly, and avoiding evening use of melatonin-suppressing substances, including alcohol and medications such as beta-blockers.

People's behavior after bedtime also counts. "They should avoid even brief intervals of [bright] light at night," says Reiter. "A nightlight is generally safe," he adds, because dim light has relatively little effect on melatonin.

Schernhammer offers similar advice: "If [getting up] to go to the bathroom, avoid turning on the light, or keep it dim."

But other scientists say that it's unclear how much a quick trip to an illuminated bathroom affects melatonin in the blood. "It's probably inconsequential," says Mark Rea, director of the Lighting Research Center at Rensselaer Polytechnic Institute in Troy, N.Y.

Reiter offers some other strategies for maintaining melatonin production. Blue or white light suppresses melatonin more effectively than red or yellow does (*SN: 4/16/05, p. 253*), so lights could be designed to filter out the offending wavelengths, Reiter says. Or people could strategically don tinted, wraparound glasses to achieve the same result, he says.

Night-shift workers face fundamental challenges, Blask says. "Melatonin works, to a large degree, by inhibiting the cancer cells from taking up linoleic acid," he says. Cravings for fatty foods frequently assail workers in the middle of the night. As a result, many shift workers consume large amounts of linoleic acid just when their melatonin production is suppressed and unable to protect them from the polyunsaturated fat, he says.

In addition to its direct effect on breast cancer, melatonin may indirectly combat tumor growth, says Davis. Melatonin suppression encourages the ovaries to produce estrogen and other female sex hormones, which support the growth of cancerous or potentially cancerous cells in a woman's breasts.

If future studies demonstrate such indirect hormonal effects, they'll reveal yet one more way by which nighttime light exposure feeds cancer. ■

ADAPTED FROM BLASK ET AL., CANCER RESEARCH, WITH PERMISSION

MAGNETIC OVERTHROW

Physicists expose a hidden facet of a familiar phenomenon

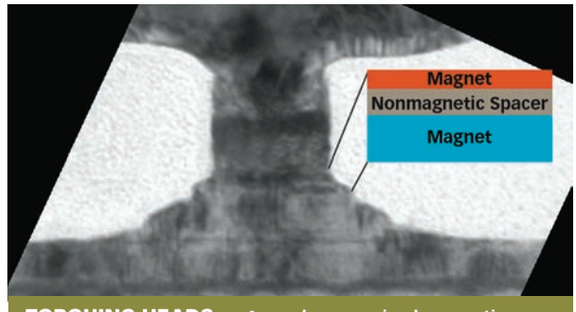
BY PETER WEISS

While conducting experiments for his physics Ph.D. in the early 1990s, Dan Ralph suddenly found himself in unfamiliar terrain without a compass. Examining nanoscale sandwiches of magnetic and nonmagnetic materials in a Cornell University lab, Ralph discovered that voltages caused by electric currents passing perpendicularly through these layers would sometimes increase abruptly for no apparent reason. "Something kind of drastic was going on," he recalls.

Ralph wrote up the bizarre results as a small part of his doctoral thesis. "I speculated all sorts of things in my thesis. It turns out all of those were wrong," he says.

Although Ralph moved on to postdoctoral studies elsewhere, his graduate adviser wasn't about to let the matter rest. "I didn't have a good idea what was going on except that it was very interesting," recalls Robert A. Buhrman. He urged other students to look at the nanostructures that Ralph had investigated, and he eventually also drew Ralph, now a Cornell physics professor, back into the studies.

Today, as a result of some clever theorizing and years of experimental work at many labs, physicists have a good idea of what was going on. They're now beginning to investigate under what conditions and for what applications magnets can respond to electricity in ways that no one recognized a dozen years ago.



TORQUING HEADS — A newly recognized magnetic effect called spin torque rotates the polarities of magnets in nanoscale stacks of metal such as this experimental read head only 33 nanometers wide.

"Ever since the discovery of magnetism, the only way known to change the direction of how a magnet points was to apply a magnetic field," notes William H. Rippard of the National Institute of Standards and Technology (NIST) in Boulder, Colo. Now, he says, research is exploring an "entirely new way" to influence magnetic behavior.

The approach relies on what physicists call the spin-torque, or spin-transfer, effect. In a nutshell, a swarm of electrons can make a magnet's polarity reverse or wobble because each electron has its own intrinsic magnetism, called its spin.

In the past few years, scientists have begun to demonstrate that the new effect could have big commercial payoffs. Some researchers have already harnessed the effect in a prototype magnetic digital memory, which may someday be a contender against, for instance, the flash memory in digital cameras and other electronics. Others have made tiny microwave beacons that can coordinate their signals in a manner reminiscent of crickets and fireflies synchronizing nightly chirrups and blinks. These developments may lead to smaller, faster, and more energy-thrifty devices for data storage, wireless communications, and information processing.

FLIP ANSWER An electron can be thought of as a tiny bar magnet whose north pole can point in any direction. Familiar magnets are objects in which multitudes of electron spins line up in one direction.

Electron spins can exert rotational forces, or torques, on each other, much as arm wrestlers create torques as they push against each other. Basic theoretical and experimental research by several scientists, including Albert Einstein, led physicists to recognize subatomic torque roughly a century ago, notes Mark Covington of Seagate Research in Pittsburgh.

In 1996, practical-minded theorists John C. Slonczewski of IBM T.J. Watson Research Center in Yorktown Heights, N.Y., and Luc Berger of Carnegie Mellon University in Pittsburgh independently proposed a novel twist on the phenomenon: If electron spins are aligned within an electric current flowing through a magnet, they might exert torques large enough to reorient the magnetization of that magnet. The theorists had in mind ultrathin sandwiches of magnetic and nonmagnetic metals similar to the oddly behaving structures that Ralph and other scientists had studied.

Physicists already knew that the spins of electrons in an electric current initially point in random directions, but as the current passes through a magnet, the spins take on the magnet's orientation. Slonczewski and Berger now proposed the reverse effect: A polarized current could force its orientation onto a magnet.

The notion that the electrons in the current might take the leading role in this wrestling match was startling. Further observations reported in 1998 by Maxim Tsoi, now of the University of Texas at Austin, and other physicists in France, Russia, and the United States seemed to bear out the theorists' proposals. "People started to say, 'Hey, maybe that's what's going on,'" Buhrman recalls.

By 1999, experimenters had confirmed the theorists' prediction. Their tests demonstrated that a polarized current that has passed through one magnetized layer and then flows through another can coerce the magnetization of the second layer to swing around to the same direction as the first. Once this alignment occurs, moreover, the polarized current flows more easily through the second layer than it had previously. Similar effects had produced the peculiar voltage hops observed by Ralph in his experiments of years earlier.

In data-storage devices, the magnetization of a layer represents a bit of digital information—a zero or a one. Flipping the magne-

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tization therefore changes the bit's value. In the write heads of hard disk drives and in some other established technologies, bit flipping relies on magnetic fields generated by other magnets, notes Chia-Ling Chien of Johns Hopkins University in Baltimore.

Creating these magnetic fields requires bulky components—a disadvantage in computer and other technologies that continue to miniaturize. What's more, because magnetic fields spread unevenly through space, they're tricky to employ, adds Rippard. The use of polarized currents, instead of magnetic fields, keeps the process neatly within the data bits, notes Chien.

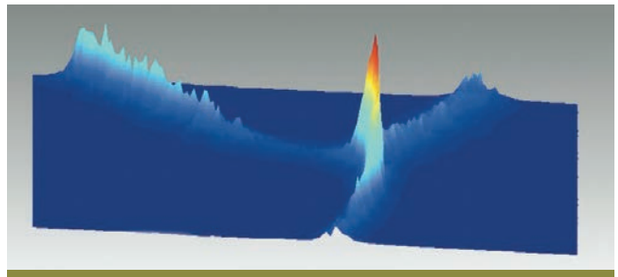
This approach probably won't be applicable to most magnetic technologies because it only works at the nanoscale. That's because the intensity of the required currents is extremely high. Flipping one bit, for instance, requires the equivalent of 5 million amperes of current per square centimeter. By contrast, ordinary household wiring carries current densities that reach only a few hundred amperes per square centimeter.

The high-intensity bit-flipping currents generate much heat. That would be a problem for larger devices, but those spanning mere tens to hundreds of nanometers have high ratios of surface area to volume and so can dissipate heat effectively.

Among researchers quick to embrace the spin-torque approach are the developers of magnetic random access memory, or MRAM—which many data-storage specialists regard as the most promising memory chip of the future (*SN: 12/18&25/04, p. 389*). Spin torque offers a way to circumvent flaws of conventional MRAM designs, in which currents in pairs of crisscrossing wires generate magnetic fields to flip bits. But fields along single wires can make nearby bits unstable—a problem expected to get worse as memory bits are crammed closer together. On the other hand, spin-torque flipping is predicted to get easier as memory chips shrink.

At the International Electron Devices meeting last month in Washington, D.C., a team of researchers from Sony Corp. in Atsugi, Japan, reported the first prototype magnetic-memory chip composed of an array of spin-torque bits. Because spin-torque switching is more efficient than magnetic field methods, the 4-kilobit chip, dubbed the spin-RAM, uses only one-twentieth as much power to flip a bit as does conventional MRAM, the researchers claim.

"This may be a breakthrough in nonvolatile high-density memory for consumer applications," says Tom Bonifield of Texas Instruments in Dallas.



SPIN-CHRONY — This data plot shows the measured microwave power of two neighboring nano-oscillators spiking as the emitted wave patterns from the devices spontaneously align with each other, or phase lock, at one frequency.

TOPSY TURVY Flipping is not the only gymnastic trick that magnets can perform when hit by spin-polarized currents. They can also make their magnetization directions twirl like dervishes.

That twirling, known to physicists as precession, is just unconsummated flipping, says Rippard. It takes place when, in the presence of an external magnetic field, spin currents are not large enough to completely overthrow the previous magnetization. Instead they tip the magnetization direction, or arrow, only partway toward a reversed configuration, pushing it out of alignment with the external field. That field then forces the arrow to wobble, or precess, as the shaft of an unsteady top does.

Changing the precession speed is as easy as turning a knob: The stronger the current, the faster the twirl. That tunability could prove handy for microwave generators and detectors, which are used in a range of applications, including collision-avoidance and other radar systems and wireless devices such as cell phones, says Frederick B. Mancoff of Freescale Semiconductor in Chandler, Ariz.

Another advantage of the new devices is how rapidly they can oscillate. Already at 35 billion cycles per second, or gigahertz (GHz), the rates are expected to reach 100 GHz, says Mancoff. Higher-frequency signals carry information faster than lower-frequency ones do. Today's cell phones typically operate at 1 to 2 GHz.

Recent results suggest a way to overcome a potential problem with the oscillators. A lone nano-oscillator produces signal strengths of only trillionths to billionths of a watt. That "won't give you enough signal to be useful," notes Jordan A. Katine of Hitachi San Jose (Calif.) Research Center.

Two teams—one composed of Katine, Rippard, and other NIST researchers and the other including Mancoff and his Freescale colleagues—have tested pairs of spin-torque structures. The groups

Head Ache

One scientist's technological advance can be another's nuisance

Despite the technological promise of spin-torque effects, their impacts on nanostructures are not always welcome. In the hard disk–drive industry, for instance, scientists have identified spin torque as a looming threat. In particular, it's expected to pose a problem for the detectors, known as read heads, that recognize the zeroes and ones of digital data by sensing the orientations of magnetic bits on hard disks.

Each detector consists of stacks of magnetic and nonmagnetic metals. It works by allowing one of its magnetic layers to align with the magnetization of one of the bits on the hard disk. That alignment results in a telltale electrical resistance in the stack.

To deal with the more densely packed disks expected in the next few years, prototype next-generation read heads have to be smaller than those in use today. So, electric-current densities in the prototypes have crossed into the range at which the spin-torque effect is showing up, says Jordan A. Katine of Hitachi San Jose (Calif.) Research Center.

Unabated, the changes to the orientation of the magnetic layer in the head that result from uncontrolled spin currents are now becoming as large as those from the underlying data's magnetic fields are. Consequently, the spurious spin torque–caused signals are swamping the legitimate bit readings. "We don't like it when that happens," Katine adds.

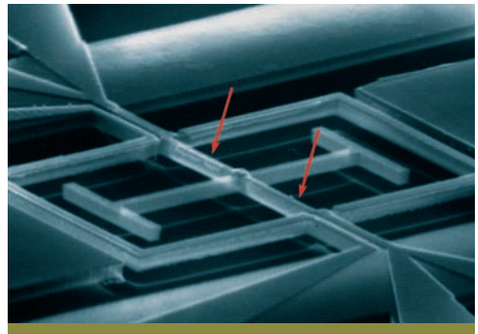
Researchers are investigating ways to cancel the torque without suppressing resistance changes in the head that are necessary to decode stored information. One potential fix would include adding to the read head extra magnetic layers designed to generate electrons polarized oppositely to those that cause the torque. But, Katine notes, "finding the best ways [to counteract spin torque] is still a very active area of research." —P.W.

NIST MAGNETICS GROUP

independently observed that oscillations of structures separated by only a few hundred nanometers became synchronized. This phase locking resembles the synchronization of such physical and biological systems as pendulums swaying, planets orbiting the sun, and insects signaling.

The experiments, described in two reports in the Sept. 15, 2005 *Nature*, showed that the joint output of a pair of synchronized oscillators is approximately four times as great as the power of a single oscillator. For larger numbers of oscillators in close proximity, the power should rise as the square of their number, the NIST group predicts. In that case, an array of fewer than a dozen nano-oscillators, occupying only a few square micrometers of a chip, in total, could produce sufficiently strong signals for practical applications.

In work reported in the Aug. 5, 2005 *Physical Review Letters*, the NIST team demonstrated that nano-oscillators synchronize with incoming microwaves, suggesting that the devices might be suitable for making directional receivers and transmitters that can pick up or radiate microwave energy in chosen orientations. The technology "could be a way toward nanoscale wireless communications—for instance, from one chip to another chip in a computer," Rippard says. Chips or cards with fewer wires may be simpler to make, denser, and faster than conventional wired circuits, he adds.



TELLTALE TILT — To mechanically detect torques exerted by electrons, this prototype, teeter-totter–like microstructure uses a nanoscale wire (arrows) that's magnetic iron for half its length and nonmagnetic gold for the rest.

G. ZOLFAGHARKHANI AND P. MOHANTY/BOSTON UNIVERSITY

COMING ATTRACTIONS Scientists are considering where, beyond MRAM and oscillators, this new form of electromagnetic muscle is leading.

One possibility is a more exotic form of spin-torque-assisted memory. In a U.S. patent issued in late 2004, MRAM pioneer Stuart S.P. Parkin of IBM Almaden Research Center in San Jose, Calif., suggests adorning semiconductor chip surfaces with vertical U-shaped wires, up to 20 micrometers tall, made of a magnetic material. Each wire could store data bits as neighboring blips of magnetization, arranged like beads on a necklace.

A spin-polarized current passing through the wire could shunt the bead-like memory regions back and forth past a read-write head at the U's base. Such a system could achieve data-transfer and storage capabilities that might eventually challenge hard disks, Parkin proposes.

Spin torque might even have a mechanical realization, contends Pritiraj Mohanty of Boston University. He and his colleagues are building a nanoscale I-shaped mechanical balance expected to tilt in response to spin-polarized currents and give a polarized electrical response to being tilted.

Such a "spin battery" could prove very important, Mohanty claims, because a new, electron spin–based approach to information processing, called spintronics, lacks reliable ways to generate spin-polarized currents on demand.

In the Sept. 2, 2005 *Physical Review Letters*, theorists in Russia, China, and Sweden calculated how much spin current a nanoscale I-beam might detect and generate. "You can get a huge effect—big enough to think about practical devices," Mohanty says.

Now that engineers of the nanoworld can make flows of torque move in and out of structures at will, many more unexpected twists on technology are bound to follow. ■

OF NOTE

PLANETARY SCIENCE

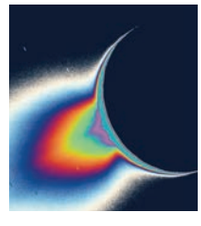
Moon spray

Geysers of icy material are erupting from Saturn's tiny moon Enceladus, providing incontrovertible proof that the moon is geologically active. Recent images taken by the Cassini spacecraft, which has toured the Saturnian system since July 2004, show the jets shooting far above the icy satellite's south-polar region.

A spectrometer on Cassini had previously detected a large cloud of water vapor above the south pole when the craft passed within 175 kilometers of Enceladus last July (*SN: 8/27/05, p. 141*). Researchers conjectured that linear surface fractures at the pole, dubbed tiger stripes, provide a conduit for ice to vaporize from the moon and continually replenish the cloud. The moon is known to feed material to Saturn's tenuous E ring. The new images, combined with spectra that identify ice particles in the geysers, suggest how that transfer could be made.

Pictures released by NASA show that the jets soar up to 300 km above the surface of Enceladus. The moon itself is only about 300 km in diameter.

For planetary scientists, "there is little that can compare to the sighting of activity on another solar system body," says Cassini imaging team leader Carolyn Porco of the Space Science Institute in Boulder, Colo. "This has been a heart stopper." —R.C.



ICE FOUNTAINS Backlit by the sun, Saturn's moon Enceladus shows icy material streaming from a source somewhere in the body's south-polar region.

JPL/NASA, SPACE SCIENCE INSTITUTE

BIOMEDICINE

Protein exposes long-term risk from heart problems

Since 2000, doctors have used elevated blood concentrations of a protein called B-type natriuretic peptide (BNP) to detect incipient heart failure in people with chest pain or other inconclusive symptoms.

BNP might also be a tool for predicting a person's risk of death, researchers report in the Dec. 14, 2005 *Journal of the American Medical Association*.

The team measured BNP in 4,266 patients entering hospitals with various symptoms of heart problems, retested most of them 4 months later, and followed as many patients as possible for 2 years. By that time, 230 of the patients had died.

Those patients who had BNP concentrations of more than 80 picograms per

milliliter of blood at admission and at the 4-month checkup were three times as likely to die within 2 years as were patients who had BNP concentrations below 80 pg/ml over the first 4 months of the study, says study coauthor David A. Morrow, a cardiologist at Brigham and Women's Hospital in Boston.

Ideally, he says, the findings will encourage research into drugs that would offset the effects of high BNP. Meanwhile, the best options for patients with this marker are aggressive cholesterol lowering accompanied by treatment with platelet inhibitors and other standard heart disease drugs, he says. —N.S.

EARTH SCIENCE

Estimating a temblor's strength on the fly

New analyses of ground motions caused by large earthquakes suggest that it may be possible to estimate the full magnitude of such quakes immediately after they start rumbling. That could enable emergency systems to better warn distant populations of a temblor before it reaches them.

Currently, it isn't possible to measure an earthquake's total magnitude until the rumbling has stopped. That's because the seismic energy that's released depends on the total slippage that occurs between two sides of a fault, says Richard M. Allen, a seismologist at the University of California, Berkeley.

He and his colleagues have discovered a quick way to estimate a quake's magnitude if there happens to be a seismometer near its epicenter.

A seismometer within 100 kilometers of the epicenter records both high- and low-frequency vibrations, whereas instruments farther away receive only low frequencies. After studying ground-motion patterns of 71 quakes recorded by nearby seismometers, Allen and his colleagues noticed that the relative amounts of energy going into the two vibration categories varied systematically with the size of the quake.

Although fault slippage in most small quakes included in the study lasted only a second or so, several of the large quakes rumbled for more than 30 seconds. Nevertheless, the researchers found that the ratio of seismic energy received at high and low frequencies during the first 4 seconds of ground motions spreading from the quake enabled the team to estimate the quake's full magnitude.

FINDING FAULT A new method of analyzing seismometer data could enable scientists to more quickly estimate the magnitude of damaging quakes, such as the magnitude–6.9 temblor that struck the San Francisco area in October 1989.

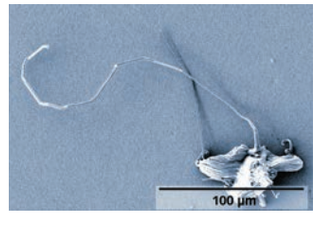
The technique may make it possible for scientists to more quickly recognize that an ongoing earthquake will be large and damaging, says Allen. He and his colleagues report their findings in the Nov. 10, 2005 *Nature*. —S.P.

TECHNOLOGY

Facing a hairy electronics problem

Three satellites have gone dead because of whiskers. Last spring, a whisker shut down a Connecticut nuclear power plant. The culprits aren't errant facial hairs: They're metal filaments that spontaneously sprout from electroplated metal films in electronic devices, where they can short out circuits. By tracking properties of such films for up to a year, researchers have now learned more about the films' internal stresses, which are suspected of causing whisker growth.

The whisker problem largely disappeared in the 1960s with the introduction of lead-tin films in electronics. Researchers had found that metal combination to be almost immune to the problem. But a worldwide drive to eliminate lead from electronics products has resurrected the menace. The European Union, for instance, begins its electronics-lead ban next summer.



WIRY ENEMY Metal whiskers sprouting spontaneously from a tin-copper film reached the lengths shown here in a half year.

Scientists have long suspected that by launching a whisker, a film relieves itself of compressive stress. Many factors contribute to such stresses, but just how they do so remains murky. Electroplating introduces stresses into films, but whiskers research has focused largely on stresses created by chemical reactions in the films, such as those between tin and copper.

To investigate both processes, metallurgist William J. Boettinger of the National Institute of Standards and Technology (NIST) in Gaithersburg, Md., and his colleagues made thin bronze cantilevers, electroplated them with tin or tin alloys, and then monitored flexing of the strips in response to compressive or tensile stresses in the films' microstructures.

Even accounting for the chemical reaction–caused stresses, those initiated by the electroplating still played a large role in whisker formation, the scientists report in the November 2005 *Acta Materialia*.

The NIST results "will be very helpful in linking the plating condition to whisker growth," comments materials scientist King-Ning Tu of the University of California, Los Angeles. —P.W.

ANTHROPOLOGY

European face-off for early farmers

A new analysis of modern and ancient human skulls supports the idea that early farmers in the Middle East spread into Europe between 11,000 and 6,500 years ago, intermarried with people there, and passed on their agricultural way of life to the native Europeans.

C. Loring Brace of the University of Michigan in Ann Arbor and his colleagues compared 24 measurements for each of 1,282 skulls from current and prehistoric populations in Europe, the Middle East, and sub-Saharan Africa. The sample included 201 skulls from early farmers and 219 skulls from Bronze Age people, who lived between 4,300 and 2,700 years ago.

Modern populations from Scandinavia to the Middle East display close genetic links, reflected in skull similarities, Brace's team reports in an upcoming *Proceedings of the National Academy of Sciences*. Ancient farmers and their Bronze Age successors share many skull features but display a considerably weaker anatomical link to modern Europeans, especially in northern regions, the researchers say.

These results fit a scenario in which farming spread into Europe via population mixing rather than by natives simply adopting agriculture (*SN: 12/3/05, p. 358*), the investigators propose. They say that facial traits of early immigrants have become diluted through intermarriage. —B.B.

C. MEYER/USGS; BOETTINGER ET AL./ACTA MATERIALIA

Books

A selection of new and notable books of scientific interest

SKY IN A BOTTLE

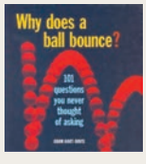
PETER PESIC

Why is the sky blue? Children and philosophers alike have pondered this question throughout history. The sky's signature color has been attributed to factors ranging from suspended dust particles to reflections of light from Earth's oceans. Aristotle posited that the sky's blue comes from a mixture of the dark night sky and white air. Physicist-author Pesic reviews the multitude of theories developed by other great thinkers, from Leonardo da Vinci to Johannes Kepler to René Descartes to Isaac Newton. Their ideas were based on their somewhat differing understandings of light, wavelengths, reflection, and refraction. The book chronicles the work of physicist John William Strutt, also known as the third Baron Rayleigh, who in the late 19th century developed a working explanation for the sky's blue. Pesic provides an elegant synopsis of the scientific investigation into the sky's color as well as an appendix of experiments for readers seeking to explain some of the sky's mystery for themselves. ***MIT Press, 2005, 256 p., b&w illus., hardcover, $24.95.***

WHY DOES A BALL BOUNCE? 101 Questions You Never Thought of Asking

ADAM HART-DAVIS

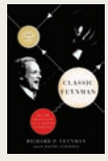
This engaging book combines Hart-Davis' loves for photography and science, applied together to explain to children the principles affecting many interesting common phenomena. The 101 questions asked and answered here by Hart-Davis—a scientist, writer, photographer, and broadcaster—cross a variety of subjects. Ever wonder whether dinosaurs could swim, why knots don't come undone, or how plant breeders have made blue carnations? Or whether shadows form in space or why electricity makes sparks? Hart-Davis addresses these questions and more in a straightforward and entertaining narrative. Throughout, he provides interesting facts in sidebars and challenges readers to take the initiative to illustrate various principles themselves. The intriguing color photographs, all by Hart-Davis, capture these phenomena in spectacular detail. For ages 9-12. ***Firefly, 2005, 224 p., color photos, hardcover, $19.95.***



CLASSIC FEYNMAN: All the Adventures of a Curious Character

RICHARD P. FEYNMAN AND RALPH LEIGHTON, ED.

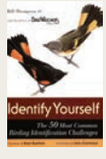
This bongo-playing, wisecracking, Nobel prize–winning physicist's larger-than-life personality elevated him to icon status within the world of science. Among his many heralded achievements, he developed what would become the standard notation for particle interactions and helped determine why the Challenger Space Shuttle exploded. His ability to tell stories that were at once informative and entertaining made his physics lectures famous. This book compiles Feynman's accounts, his "adventures of a curious character," that were previously published in the best-selling books *Surely You're Joking, Mr. Feynman!* and *What Do* You *Care about What Other People Think*? This new volume includes essays on Feynman by Leighton, Freeman Dyson, and Alan Alda. As a bonus, the book comes with an hour-long audio compact disk featuring the physicist's recollections of his experiences with the atomic bomb. This recording and the book's printed stories reveal Feynman's intellect, his commitment to experimentation, and his personal life. In one essay, for instance, Feynman commemorates his first wife Arlene, who died of tuberculosis only a few years into the couple's marriage. ***Norton, 2005, 608 p., hardcover, $29.95.***



IDENTIFY YOURSELF: The 50 Most Common Birding Identification Challenges

BILL THOMPSON III AND THE EDITORS OF *BIRD WATCHER'S DIGEST*

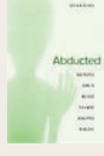
The essence of bird-watching is identifying the birds viewed, yet that task is often fraught with frustration. How does one tell a black-billed cuckoo from a mangrove cuckoo, or a downy woodpecker from a hairy woodpecker? Oftentimes, plumage and other features are so similar between species that differentiating them can seem close to impossible. This guide addresses 50 of the most commonly encountered bird-identification challenges in North America. Thompson, editor of *Bird Watcher's Digest*, provides many tips for birders and declares his top 20 rules for bird identification. Rule number 1: "Look at the bird, not at the book." After other basics, such as bird anatomy, easy-to-read and often-humorous chapters feature challenging bird groups, from waterfowl to finches. Each overview includes several full-color illustrations. ***Houghton Mifflin, 2005, 416 p., color illus., paperback, $19.95.***



ABDUCTED: How People Come to Believe They Were Kidnapped by Aliens

SUSAN A. CLANCY

Polls suggest that more than 90 percent of people believe that extraterrestrials exist. A small but significant number of those people believe that they've been abducted by aliens. Clancy's graduate studies of human memory and, in particular, of so-called repressed memories led her to the much-maligned topic of alien abduction and to a new understanding of the claimed abductees. The author found average, sane people who happen to have adopted the same peculiar belief to explain abnormal experiences. She examines why abduction stories tend to be so consistent, the effect of hypnosis and popular culture on abduction claims, and the sometimes-terrifying, sometimes-inspiring personal stories of people she interviewed. Clancy focuses not on whether her subjects were actually abducted but on why they believe they were. ***Harvard Univ. Press, 2005, 162 p., hardcover, $22.95.***



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LETTERS

Death in the Americas

I was wondering if researchers have given any thought to the idea that in the same way that disease devastated human populations after the European discovery of the Americas, perhaps disease was a contributing factor in the demise of much of the fauna of the Western Hemisphere ("Caribbean Extinctions: Climate change probably wasn't the culprit," *SN: 10/29/05, p. 275*). Could domesticated animals traveling with the humans, or maybe wild animals making use of the same pathways, have carried pathogens so alien to the native populations that they perished?

BOB STEWART, FLORENCE, MASS.

Couldn't most of the life-threatening damage have been caused by excessive radiation? That is, larger animals would have taken bigger doses—especially with forests dwindling—while smaller animals could more easily have found shelter. Meanwhile, seagoing creatures had the advantage of a water shield.

BUZ CRAFT, WILLS POINT, TEXAS

A hypervirulent disease, climate change, and rapacious hunting by humans newly arrived in the Western Hemisphere—alone or in combination—are often blamed for the megafauna die-offs at the end of the last ice age (SN: 12/4/99, p. 360). Either wild or domestic animals could have been the source of disease, if it played a role. On the idea of excessive radiation as extinction culprit: The scenario doesn't explain why similar extinctions weren't happening simultaneously on nearby continental landmasses. —S. PERKINS

Call that singing?

Humans vocalize primarily non-harmonically (talk), but some can also vocalize harmonically (sing). Birds, likewise, mostly vocalize non-harmonically (chatter), but some can vocalize harmonically. It would be most helpful, when discussing birds, mice, and whale "songs," ("Beyond Falsetto: Do mice sing at ultrasonic frequencies?" *SN: 11/5/05, p. 293*) if scientists would clarify whether they mean non-harmonic or harmonic vocalizations.

PETER WILSON, SIMI VALLEY, CALIF.

Correction *The picture of artery cross sections in "Mixing Vessel: Air pollution helps cholesterol clog arteries," (*SN: 12/24&31/05, p. 404*) should have been credited to Qinghua Sun et al./*Journal of the American Medical Association.

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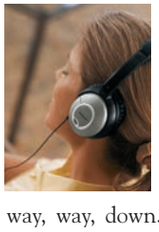

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