SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SEPTEMBER 13, 2003 PAGES 161-176 VOL. 164, NO. 11

mega-digital storage
enzyme–lung cancer link
black hole's ultra-bass tone
european floods abating?

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flyer beware

AIRBORNE HAZARDS OF VOLCANIC ASH

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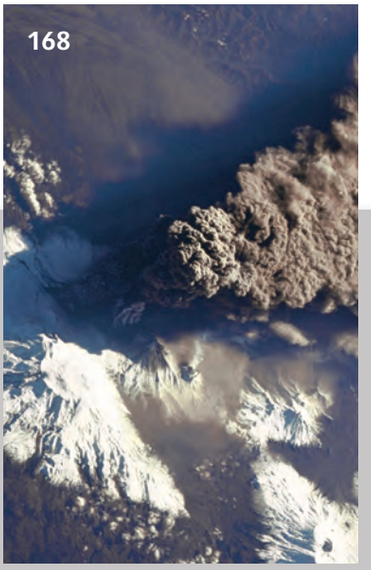

Features

This Week

Of Note

Departments

Cover This October 1994 eruption of Klyuchevskaya on Russia's Kamchatka Peninsula belched out an ash plume that stretched more than 1,000 kilometers downwind and forced the diversion of 70 airline flights per day. Although there haven't been any fatalities from aircraft flying into ash clouds, there have been many near-accidents. (Earth Sciences and Image Analysis Laboratory/NASA Johnson Space Center) Page 168

THIS WEEK ONLINE
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Green tea and cancer Drinking green tea may lower a woman's risk of developing breast cancer. See Janet Raloff's Food for Thought.

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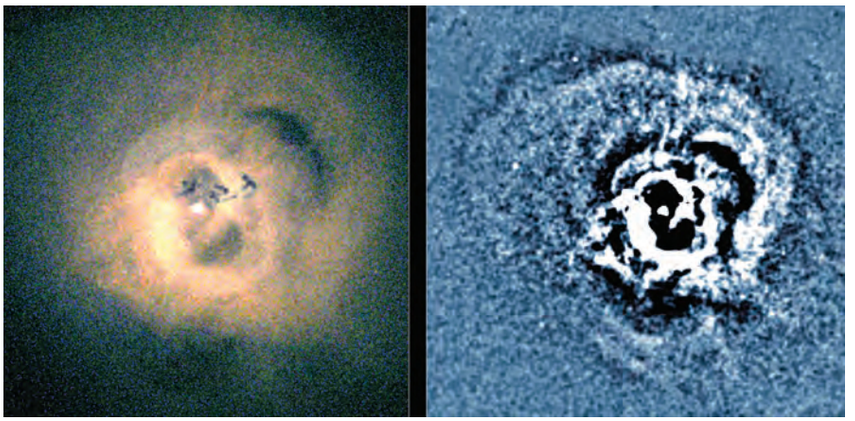
A Low Note in Cosmos

Sounding out a new role for black holes



COSMIC SOUND X-ray image of the center of the Perseus galaxy cluster (left). Image processing reveals what appear to be concentric sound waves (right).

FABIAN ET AL., CAMBRIDGE/CXC/NASA

It's a tone no one can hear, generated by a body no one can see, yet its reverberations may be huge. Astronomers reported this week that they have for the first time detected sound waves generated by a black hole.

The finding appears to solve a long-standing puzzle about the behavior of gas at the center of galaxy clusters. It also points to a previously unrecognized role for supermassive black holes: limiting how big a galaxy can become.

Andrew C. Fabian of the University of Cambridge in England and his colleagues made their discovery by examining the bright X-ray glow from gas that bathes the Perseus cluster of galaxies, 250 million light-years from Earth. Most of the gas in the cosmos lies between widely separated galaxies but emits so little radiation that it's difficult to detect. However, the immense gravity of a cluster squeezes and heats the gas so that it emits X rays.

Using a 53-hour-long observation of Perseus with NASA's orbiting Chandra X-ray Observatory, Fabian's team found circular ripples in the cluster's gas, similar to those created when a rock is dropped into a pool of water. The team attributes the ripples to sound waves generated when jets emanating from Perseus' central black hole plow into the cluster's intergalactic gas.

"We [had previously] observed the prodigious amounts of light and heat created by black holes, now we have detected the sound," Fabian says. He announced his team's findings at a NASA briefing in Washington, D.C.

The ripples are separated by about 35,000 light-years—which produces a B-flat 57 octaves below middle C. The black hole's tone is far lower than the human ear can discern.

The note is the deepest ever detected in the universe, Fabian says. But the Perseus sound waves are more than a curiosity.

Astronomers haven't been able to explain why the center of Perseus and other galaxy clusters are as hot as 50 million kelvins, even though the gas there radiates energy away and should therefore be cold. Fabian's team says the sound waves solve the mystery. When they're absorbed by the cluster gas, the waves unleash energy equivalent to 100 million supernova explosions. That's enough to keep the gas hot within the innermost 150,000 light-years of the cluster, Fabian says.

To explain how the newly detected sound waves are generated, Fabian points to previous Chandra observations of the Perseus cluster, which had revealed two large bubbles extending away from the central black hole. Fabian's team proposes that the bubbles originated when jets of material from the black hole slammed into cluster gas. The inflation of the bubbles produced shocks that were converted to the pressure waves, or sound waves, which spread out in all directions, Fabian suggests. Sound waves that are stopped within the cluster not only heat its core but also may drive some material outward.

Fabian speculates that a similar outward push by sound waves occurs in some individual galaxies that house a supermassive black hole. Preliminary calculations indicate that sound waves would pass freely through the gas of a low-mass galaxy but would be absorbed by the gas of a heavier one, Fabian told *Science News*.

Because sound waves generated by a supermassive black hole may drive material out of these heavier galaxies, the black hole could limit the amount of material a galaxy can pack on, thereby restricting how big it can get. Because the sound waves can carry energy thousands of light-years from a supermassive black hole, they may in part account for its influence on the growth of galaxies (*SN: 4/5/03, p. 214*).

Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Md., cautions that the proposed link between black hole sound waves and cluster heating requires special circumstances. To be absorbed, the sound waves must have just enough oomph to travel through much, but not all, of the cluster's gas. Also, Mushotzky notes that Fabian's scenario requires that black holes pump out jets over periods 10 to 50 times longer than theorists have suggested.

None of these potential problems necessarily negates the findings, Mushotzky adds. If Fabian's team is correct, he says, the new observations are "of fundamental importance in all of astronomy and cosmology." —R. COWEN

Fusion Boost

Promising path to heavy nuclei

Making heavy, artificial atomic nuclei has long been part of the program for answering fundamental questions about matter and the universe, but it hasn't been easy. Physicists are looking toward techniques that forge hefty nuclei by fusing lighter, radioactive ones. Now, results of an accelerator experiment at Oak Ridge (Tenn.) National Laboratory suggest that the approach may prove even more fruitful than many nuclear scientists had anticipated.

Since the 1940s, researchers have created various types of heavy nuclei that don't exist naturally on Earth. They've produced those particles mainly in accelerators by slamming stable, nonradioactive nuclei together. Yet thousands of potential heavy isotopes remain beyond the capacity of that process.

So, nuclear physicists are turning to unstable, radioactive nuclei. Besides providing information about nuclear structure, that strategy might lead to novel radioisotopes for medicine, improved understanding of nuclear-weapons blasts, and insights into astrophysical phenomena such as

supernovas. Last year, nuclear physicists in the United States named as their top construction priority a proposed $900-million device devoted to creating and studying unstable nuclei. Researchers in Europe and Japan are developing similar facilities.

Less electrostatic repulsion occurs during collisions including nuclei that are unstable because they have excess neutrons than during collisions of stable nuclei. So, scientists expect collisions including unstable nuclei to produce fusions more readily than collisions of stable isotopes do.

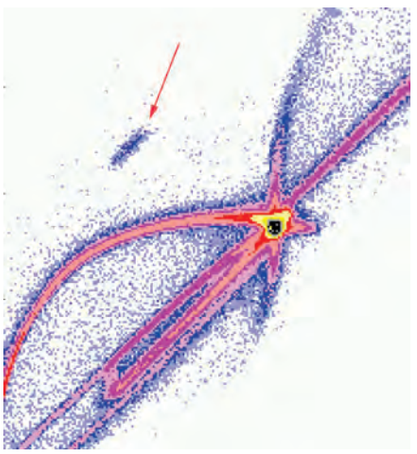
Light nuclei such as tin and nickel can also fuse at collision energies even smaller than those needed to overcome the particles' mutual electrostatic repulsion. Scientists attribute those fusions to a quantum mechanical phenomenon called tunneling, which permits neutrons or protons to pass between the colliding nuclei.

In the new experiment, J. Felix Liang of Oak Ridge and his colleagues smashed unstable nuclei of tin-132 into stable nickel-64 to make platinum-196 nuclei. The team found that low-energy reactions took place at a rate roughly 10 times as high as that when the researchers use stable tin-124 projectiles. The enhancement, to be reported in an upcoming *Physical Review Letters*, is "very exciting, very encouraging," Liang says.

"I was hoping for something like this," comments Robert V.F. Janssens, who heads a research team using an accelerator at Argonne (Ill.) National Laboratory. "Every time we've looked at neutron-rich [unstable] nuclei, we have found surprises," he says.

The details of the low-energy fusion enhancement in the Oak Ridge experiment remain unclear. Moreover, the researchers don't yet know whether the fusion enhancement will persist when they use other projectiles and targets, Liang adds.

The new results raise the prospect that future accelerators will create exotic nuclei more readily than have those facilities handling only stable nuclei. Team member Walter Loveland of Oregon State University in Corvallis says that if some of those exotic nuclei prove to be highly stable, as many theorists have predicted (*SN: 6/12/99, p. 372*), "the whole of chemistry and physics of heavy atomic nuclei would open up." —P. WEISS



SILVER BULLETS? When projectiles of radioactive tin-132 nuclei struck nickel-64 atoms in a stationary target in an accelerator, the two types of particles fused into platinum-196 nuclei at an exceptionally high rate. The small patch of dots denoted by the arrow represents the platinum-196 products.

LIANG ET AL./PRL

Damage Patrol

Enzyme may reveal cancer susceptibility

Breaks in a person's DNA underlie the cancer-causing effects of cigarette smoke. Such DNA damage can lead to mutations that bring about the aberrant cell growth of cancer. But since not all smokers get lung cancer, scientists have assumed that some people mend their damaged DNA strands better than others do. With this in mind, researchers have been searching for enzymes that orchestrate DNA repair and mitigate cancer risk.

Now, scientists report that people with lung cancer are shortchanged when it comes to at least one type of DNA repair. Such patients show less activity of a repair enzyme called 8-oxoguanine DNA *N*-glycosylase (OGG) than people without the disease do, researchers say in the Sept. 3 *Journal of the National Cancer Institute*. The enzyme fixes DNA that's been damaged by oxidation.

"We think testing for OGG activity will provide a useful tool for lung cancer prevention," says study coauthor Zvi Livneh, a biochemist at the Weizmann Institute of Science in Rehovot, Israel.

For their study, Livneh and his colleagues recruited 136 people, half with lung cancer and half without any cancer. Tests of OGG activity in the volunteers' blood samples indicated that while only 4 percent of people free of cancer were significantly short on OGG activity, 41 percent of the cancer patients were.

Both groups included smokers and people who had never smoked. Smoking didn't affect OGG activity in either group, the researchers found. Moreover, the tumors in the cancer patients didn't appear to be responsible for their lower OGG activity, says Livneh, because blood tests before and after surgery to remove tumors revealed no change in participants' OGG activity.

To ascertain whether OGG activity changes over time, the researchers drew blood samples over 3 years from eight of the healthy nonsmokers. The OGG scores of each of these volunteers remained stable.

Smoking boosts a person's lung cancer risk 10-to-20-fold. The Israeli researchers calculate that smoking and having low OGG could together increase an individual's risk of lung cancer to more than 100 times that of someone who has never smoked and has average OGG activity.

Screening smokers for low OGG activity could pinpoint individuals at especially high risk for lung cancer, Livneh says. "These smokers, we believe, will have a stronger motivation to quit because they have a personal susceptibility," he adds.

Before OGG screening is ready for the clinic, however, more testing is needed, says Neil Caporaso, an epidemiologist at the National Cancer Institute in Bethesda, Md. Future OGG studies will need to assess participants' intake of antioxidants, such as vitamins C and E and the fruits and vegetables that contain them, he says. He also recommends that researchers note each study participant's smoking behavior—heavy or light, current or former—to get a better idea of the DNA-repair task that's confronting him or her.

"Large-scale work in human populations will be required to confirm effects in realistic settings and to gauge public health implications," says Caporaso. "The investment should be worth it." —N. SEPPA

DNA Tie for Two Disorders

Genetic defects link psychiatric ailments

Schizophrenia and bipolar disorder may share more than a propensity for wreaking havoc on mental life. These severe psychiatric disorders, each of which occurs in about 1 in 100 adults, rest on identical flaws in a set of genes that produce a protective covering for brain cells, a new study suggests.

The critical genes are active in brain cells called oligodendrocytes, say neuroscientist Sabine Bahn of the University of Cambridge in England and her colleagues. Oligodendrocytes produce fatty myelin molecules that coat brain cells and influence their transmission of electrical impulses.

More than a dozen proteins that oligodendrocytes use to make myelin occurred in unusually low concentrations in the preserved brains of 15 people with schizo-

phrenia and 15 people with bipolar disorder, Bahn's team reports in the Sept. 6 *Lancet*. Several other proteins, which regulate the genes that code for the myelin-making proteins, also exhibited low concentrations in both groups of brains. No such disturbances appeared in the preserved brains of 15 people who had had no mental disorder.

"Our findings raise questions about myelin's role in these psychiatric illnesses," Bahn says. She's now directing an analysis of myelin-related proteins in 150 preserved brains from people with schizophrenia, bipolar illness, or no mental disorder.

If the results hold, they will indicate that disrupted myelin production may set the stage for psychosis, a warping of one's sense of reality that often occurs in schizophrenia, bipolar disorder, and brain ailments such as Alzheimer's disease, Bahn suggests.

Signs of schizophrenia include apathy, disorganized behavior, and psychotic symptoms such as hallucinations and delusions. Bipolar disorder, sometimes called manic depression, features swings from severe depression to a type of agitated euphoria called mania. Psychotic delusions, say of being invincible, are a common element of mania.

Earlier studies linked schizophrenia to disturbances in myelin-producing genes in specific brain regions. Further work needs to examine whether the same regional effects characterize bipolar disorder, say Kenneth L. Davis and Vahram Haroutunian, both psychiatrists at Mt. Sinai School of Medicine in New York, in a commentary published with the new report.

Psychiatrist Elliot S. Gershon of the University of Chicago calls Bahn's report "very interesting and exciting news." In the May *American Journal of Human Genetics*, Gershon and his coworkers reported that alterations of two other genes, found on chromosome 13, frequently occur in people with either schizophrenia or bipolar disorder. The functions of those genes are poorly understood.

Accumulating data also suggest that additional genes, located on chromosome 8, contribute both to bipolar disorder and schizophrenia (*SN: 9/5/98, p. 151*), Gershon adds.

However, any potential link between these two mental disorders is controversial. For instance, a study led by Pekka Tienari of Finland's University of Oulu found that having a biological mother with schizophrenia didn't increase rates of bipolar illness and other mood disorders in nearly 400 adults who had been adopted as infants. These results, published in the September *American Journal of Psychiatry*, clash with the notion that schizophrenia and bipolar disorder share genetic influences.

The two disorders stem from various influences, some shared and some unique, Bahn contends. "It's like inflammation," she says. "There can be many causes for the same symptoms." —B. BOWER

Sweet Relief

Comfort food calms, with weighty effect

The sweet and fatty foods that people often turn to in times of stress might in fact relieve anxiety. That's the good news in an innovative biological theory of people's responses to stress. The bad news is that for those with chronic stress, extra servings of comfort food come with potentially dangerous baggage—extra fat around the abdomen.

Chronic stress, such as financial worries, is less well understood than are intermittent bouts of acute stress. For example, scientists know that when a cat is suddenly attacked by a dog or a person prepares to give a speech, the adrenal gland pumps up production of stress hormones, including those known as glucocorticoids. When present at high-enough concentrations, glucocorticoids provide feedback to the stress-response system, eventually shutting it down.

However, it's unclear how the stress response is controlled in animals that are anxious for days at a time. In an upcoming *Proceedings of the National Academy of Sciences*, physiologist Mary F. Dallman of the University of California, San Francisco and her colleagues aim to close that knowledge gap.

Drawing on their rat studies and experiments done by others, the scientists propose that glucocorticoids work differently in the long term than they do in the short term. When chronically present in the brain and body, the hormones maintain the stress response instead of shutting it down. At the same time, they drive animals to seek out pleasurable foods and direct the added calories to accumulate as abdominal fat.

However, there is a brake on the process, at least in animal experiments. That extra fat eventually checks the glucocorticoids' alarmist effects and tells the brain to take it easy again.

Results from several experiments with rats support this view, the scientists say. In one of them, Dallman and her colleagues simulated chronic stress by increasing the brain concentration of a rodent version of the glucocorticoid called cortisol. As cortisol concentration rose, the rats responded by drinking increasingly more sugar water, eating increasingly more lard, and gaining abdominal girth.

In another experiment, the researchers found that rats with extra padding produce less-than-average concentrations of a brain chemical that triggers early molecular events underlying the stress response.

"If you put on some extra weight, there seems to be some sort of signal that says things are better," says Norman C. Pecoraro of UC-San Francisco, a coauthor of the paper. While Dallman and her coworkers

Paper Chased

Cancer-vaccine study is retracted

A promising cancer treatment has been dealt a setback, as the authors of a key paper have reluctantly retracted their report.

Three years ago, Alexander Kugler of the University of Göttingen in Germany and his colleagues described limited success with a new cancer-vaccine strategy in *Nature Medicine* (*SN: 3/4/00, p. 149*). The researchers had taken tumor cells from people with kidney cancer, fused them to the patients' own immune cells, and injected the combination back into the patients. In several of the volunteers, this stimulated an immune response against secondary tumors and led to complete remission.

Criticism of the study's quality and ethics emerged, however, and the University of Göttingen launched an investigation. In November 2002, officials there concluded that Kugler, but not his coauthors, was guilty of negligence and that the paper didn't meet standards of good scientific practice. For example, the university's ethics committee hadn't approved the human experimentation.

Kugler's coauthors initially resisted retracting the paper because they felt the conclusions of their study remained valid, but the editors of *Nature Medicine* eventually convinced the investigators that the large number of errors in the published data and ethical lapses by Kugler warranted the action. Other researchers stress that the retraction, published in the September *Nature Medicine*, doesn't negate the potential of using fused tumor and immune cells to stimulate a patient's immune system against cancer.

"There are plenty of papers . . . that show in animal studies that the approach is valid," says Richard Vile of the Mayo Clinic in Rochester, Minn.

Work on the strategy continues. In fact, in the journal issue that carries the retraction, Vile and his colleagues describe a novel process for fusing cancer and immune cells. —J. TRAVIS

don't know what signal the abdominal fat sends, they suspect it's involved with the regulation of metabolism.

The model "puts a new and more meaningful slant on what we mean when we talk about 'comfort foods,'" says Bruce S. McEwen of Rockefeller University in New York. "These may actually calm down an important brain system linked to anxiety."

In a fast-paced society where food is easy to get, glucocorticoid action probably causes chronically stressed people to take in extra calories and to gain weight, says McEwen.

"People are somehow stressed, and they are self-medicating because food is available," adds Pecoraro.

"We also eat sugar and fat because they are good tasting and cheap," notes Adam Drewnowski of the University of Washington in Seattle. The stress response isn't the only brain pathway that controls consumption of sweet and high-fat foods, he adds.

Whatever accounts for the urge to eat a big helping of macaroni and cheese, it's best not to indulge every day. The abdominal weight gain that Dallman and her colleagues have linked to glucocorticoid action increases the risk of heart disease and diabetes. —K. RAMSAYER

River Stats Trickle In

Major floods may be waning in Europe

In August 2002, parts of central Europe experienced unprecedented flooding after record rains fell upon saturated soils and brimming reservoirs. Damages on the continent added up to more than 25 billion Euros, and in Dresden, Germany, the Elbe River reached 9.4 meters above flood stage, a level not seen since the Middle Ages.

Despite the 2002 season, a new analysis by German researchers suggests that extreme summer floods in the region aren't becoming more frequent. In fact, the scientists say, widespread inundations have been on the wane for the past century or so.

For the study, team leader Manfred Mudelsee of the University of Leipzig in Germany and his coworkers considered regional floods along the central stretches of the Elbe and Oder Rivers dating back at least 700 years. The scientists culled data from historical archives and modern instruments, and they analyzed summer and winter floods separately because they have different causes.

DEEP TROUBLE The same weather system that dumped record amounts of precipitation in Germany in August of 2002 caused massive floods in Melk, Austria.

Floods that occur from May through October typically arise during or just after long periods of precipitation, says Mudelsee. The frequency of such inundations hasn't changed significantly on the Elbe since 1820 or on the Oder since 1920. Other researchers have reported 10 major summer floods on the Elbe in the past 500 years, and 4 of those high-water events occurred between 1500 and 1550.

So-called winter floods in the region have declined, says Mudelsee. These cold-season floods are often caused by ice dams that form when frozen rivers break up in the spring. Before 1850, 91 of 103 severe winter floods on the Elbe, and 28 of 34 of those on the Oder, were influenced by river ice. Between 1930 and 1970, however, just 2 of 13 winter floods on the Elbe and 3 of 20 on the Oder were affected by ice.

Mudelsee and his colleagues also estimated the ameliorating influence of reservoirs and other flood-control measures and found that they had little effect during large inundations. The scientists report their findings in the Sept. 11 *Nature*.

"I'm not surprised that there's not been a rise in floods," says Phil Jones, a climatologist at the University of East Anglia in Norwich, England. Current amounts of precipitation aren't very different from those measured during other wet periods of the past 2 centuries. Modern floods may appear more serious than past ones largely because more people live on floodplains now than in earlier periods, he notes.

Results of many computerized climate models suggest that continuation of the current increase in average global temperature will boost evaporation from the oceans. An accompanying rise in precipitation could increase the frequency and severity of floods, some scientists say.

"I'm convinced the climate is changing, but I'm not convinced that the frequency of floods has changed," says Kenneth W. Potter, an environmental engineer at the University of Wisconsin–Madison. —S. PERKINS

DANGER IN THE AIR

Volcanoes have a long reach

BY SID PERKINS

On Dec. 15, 1989, KLM flight 867 from Amsterdam was approaching its destination in Anchorage, Alaska, when the plane flew into what appeared to be a thin layer of normal clouds. Suddenly, according to flight-crew reports, it got very dark outside and the air in the cockpit filled with a brownish dust and the unmistakable smell of sulfur. One minute after beginning a high-power climb to escape the cloud, all four of the Boeing 747's jet engines died when the combustion within them was extinguished. When the engines spun to a stop, the generators ceased making electrical power, leaving only battery-powered instruments functional. Airspeed sensors began to give false readings and then ceased to provide data. A cockpit warning light erroneously suggested there was a fire in one of the forward cargo bays.

Only after losing more than 3 kilometers of altitude did the pilots on the crippled jet get all engines restarted. Because the aircraft's front windows looked as if they'd been sandblasted, the flight crew could see what lay ahead only by leaning near the cabin walls and peering forward through the cockpit's side windows. The pilots landed the plane and its 231 passengers safely in Anchorage, but it took $80 million—including four new engines and a paint job—to restore the aircraft.

What could wreak such havoc? Volcanic ash.

Flight 867's encounter with a volcanic plume was one of aviation's most dramatic, but it's by no means unique. More than 90 aircraft have flown through ash clouds in the last couple of decades. None of those incidents has resulted in fatalities, but experts say that damages to the aircraft probably total at least $250 million.

The system now in place to warn airlines about ongoing volcanic eruptions and the locations and altitudes of the resulting ash plumes is valuable but not perfect, and scientists are working to make it better. They're improving techniques of interpreting satellite imagery, one of the cornerstones of the current warning system. They're also developing sensors that could form the heart of ground-based networks to monitor remote volcanoes or be mounted on an aircraft to scan for ash in its flight path.

TRUE GRIT — In just 5 minutes, the plume of gritty ash from a new volcanic eruption, which is invisible to aircraft radar, can reach altitudes where jets cruise.

LOOK OUT BELOW Of the 1,500 or so active volcanoes on Earth, around 600 have erupted in historical times. About 60 eruptions occur each year, several of which spew ash clouds up to altitudes where they threaten aircraft, says Ed Miller, a retired airline pilot now at the Air Line Pilots Association in Herndon, Va. On about 25 days per year, he notes, there's ash somewhere around the world at the altitudes where jets cruise.

Increasing the ash plumes' peril is their typically unthreatening appearance once they're blown downwind from a volcano. "The pilots [of KLM 867] said they flew into what appeared to be a regular cloud, and then everything went to hell," says Miller. That flight's encounter occurred almost 250 km away from Alaska's Redoubt volcano, which had begun erupting the day before.

Although the largest bits of ash fall to the ground in the vicinity of an erupting volcano, what stays aloft to waft further downwind is by no means benign. Even dust-size ash particles can sandblast windshields, infiltrate sensitive instruments, and clog engines.

Besides the particles of ash—which actually are minuscule fragments of shattered rock—volcanic plumes can contain high concentrations of water vapor, sulfur dioxide, and other noxious gases. Sulfur dioxide and water vapor react to form droplets of sulfuric acid, which over the long term can fade an aircraft's paint, etch the outside surface of its acrylic windows, and create sulfate deposits in engines.

"There's no known minimum quantity of airborne ash that won't do damage," says Leonard J. Salinas, a safety expert at United Airlines' headquarters in Chicago. "We must fly through clean air," he adds. United pilots are required to fly either upwind of a volcanic plume or at least 800 km downwind of the ash cloud's known edge. Otherwise, flights are delayed or canceled. Pilots for other U.S. airlines follow similar rules, Salinas notes.

Airlines get up-to-date information about volcanic eruptions and ash plumes from a network of nine Volcanic Ash Advisory

Centers (VAACs) in various countries, where government-funded scientists track the altitudes and positions of ash clouds just as air-traffic controllers keep tabs on all the jets in their areas. VAAC personnel get their information from multiple sources: satellite imagery, volcano observatories, sightings by pilots, and even media reports. Once an eruption has begun, VAAC scientists issue advisories at least once every 6 hours until the ash cloud can't be detected.

SKY EYES Instruments on Earth-gazing spacecraft spy volcanic plumes in various ways. For instance, a satellite-mounted instrument called the Total Ozone Mapping Spectrometer measures the amount of radiation scattered by the atmosphere within six narrow bands of ultraviolet light, data that reveal not only ozone but also sulfur dioxide aerosols typically spewed by volcanoes and smokestacks. This technique sometimes isn't sufficient to detect volcanic plumes, however, because ash particles can fall out of or drift away from the plume containing the telltale aerosol droplets, says Miller.

Although the instrument can monitor known volcanic clouds once an eruption has been detected, it's not effective for early warning of new eruptions because its orbit—which covers the entire surface of the Earth once a day—doesn't permit frequent observations of a particular spot.

Similarly, sensors on several other satellites scan Earth in various infrared-wavelength bands for evidence of sulfur dioxide plumes, sulfate aerosols, and volcanic ash. For early-warning purposes, scientists look to observations from geosynchronous weather satellites, each of which constantly monitors an entire hemisphere and beams data to Earth every 30 minutes or so. In the past, analysts relied on readings at two key wavelengths—11 and 12 micrometers—to distinguish ash-bearing clouds from those made up only of water droplets, says Gary P. Ellrod of the National Oceanic and Atmospheric Administration in Camp Springs, Md. Comparison of cloud brightness as measured in these two channels typically shows a clear difference between clouds containing volcanic ash and those containing only water droplets.

PLUME WITH A VIEW — An ash plume from the Anatahan volcano (top) 300 kilometers north of Guam shows up as a gray-bordered yellow cloud in a particular combination of infrared wavelengths (bottom).

Ellrod and his colleagues have developed an analysis technique that incorporates data from a third, 3.9-μm, infrared channel monitored by these satellites. The minerals in volcanic ash reflect this wavelength particularly well. Results of tests at his agency, which serves as part of the Washington, D.C., VAAC, suggest the new method works well for any ash plume in daylight and for those plumes moving over large bodies of water at night. The scheme also does a better job of detecting older or more diffuse ash plumes than the method that uses only 11- and 12-μm readings, says Ellrod. He and his colleagues describe the new image-analysis technique in the June 27 *Journal of Geophysical Research* (*Atmospheres*).

Another ash-detection scheme using satellite data blends information from four different wavelengths. That technique, developed by Frederick R. Mosher of NOAA's Aviation Weather Center in Kansas City, Mo., takes the same three channels of data used by Ellrod's team and adds observations at 0.6 μm, a wavelength of orange-red light. By using data from all four channels, analysts can generate an ash-cloud image that doesn't vary much between day and night. Tests suggest that this method also picks up thin cirrus clouds, however.

Soon, scientists will need to develop ways to detect ash clouds that don't depend on observations in the 12-μm wavelength. That's because the scientists and engineers who designed the newest generation of geosynchronous satellites phased out that channel, which was originally used to detect moisture at low altitudes in Earth's atmosphere. Instead, the new satellites monitor another infrared wavelength, 13.3 μm, says Ellrod. Although volcanic ash doesn't show up as well at that wavelength, he notes that he and his colleagues can still spot moderately dense ash plumes, such as those spewed from the Soufrière Hills volcano on Montserrat this summer.

Mosher's four-wavelength technique doesn't rely as heavily on the 12-μm data as the three-wavelength technique does. The loss of observations at 12 μm won't leave analysts unable to spot major volcanic eruptions, he says. However, they'll probably have trouble detecting thin ash clouds and low-altitude plumes at night.

A geosynchronous satellite that hovers over the Pacific still provides observations at 12 μm, but the one that now watches over most of North America uses the new set of wavelengths, says Ellrod. When the current Pacific satellite eventually fails, the 12-μm channel won't be available again until early next decade.

DOWN TO EARTH Even though geosynchronous satellites make round-the-clock observations and download data every 30 minutes or so, that still may not be enough to avert every ash-airplane collision. When Mount St. Helens explosively erupted in May 1980, its ash plume took just 5 minutes to reach the altitudes where aircraft typically cruise, notes United's Salinas. In that amount of time, a jet can travel as far as 65 km.

Therefore, says Salinas, an airline-industry goal is to have a warning system that can alert air-traffic controllers and airline dispatchers within 5 minutes of a volcanic eruption. Current satellites don't meet that target. In fact, he says, scientists have told him that a 5-minute warning is nearly impossible for peaks that aren't continuously watched by volcanologists at ground stations. However, a solution may be close at hand because the same sort of sensors used to survey volcanoes from space can be incorporated into ground-based equipment, as well.

PRATA

For instance, scientists from Los Alamos (N.M.) National Laboratory have deployed ground-based, infrared-sensing equipment to monitor variations in pre-eruption emissions of ash and trace gases at several volcanoes. At Popocatépetl, about 70 km southeast of Mexico City, a team including the lab's Stephen P. Love was able to detect a steady rise in the concentration of silicon tetrafluoride gas emitted by the volcano just prior to eruptions in 1997, even from sites up to 17 km away. The gas results from a chemical reaction between hydrogen fluoride vapor and the silicate minerals in volcanic ash. Looking for silicon tetrafluoride increases with such sensors might provide a way to detect impending eruptions at Popocatépetl, says Love.

PERILOUS PATHS — Flight routes over the North Pacific to and from east Asia pass over or near about 100 Alaskan, Russian, and Japanese volcanoes (red triangles).

Researchers in Australia have taken the infrared-sensor technology even further. They're now testing sensors that could be incorporated into early-warning devices that monitor volcanic activity at remote sites and phone updates to scientists via satellite. A warning could go out immediately if an eruption occurs. In field trials last June, the scientists went to Anatahan, a small volcanic island about 300 km north of Guam. That peak, which hadn't shown activity in previous historical times, had erupted May 10, says Fred Prata of the Commonwealth Scientific and Industrial Research Organization in Aspendale, Australia.

During the June tests, he and his colleagues scanned the still-erupting Anatahan from a ship, a helicopter, and the island itself. With the sort of analytical techniques used to process satellite images, the researchers could distinguish the volcano's ash plume from regular clouds. The same sensors can also indicate sulfur dioxide emissions, and the devices would work day or night, says Prata. This month, the team is conducting additional field tests at Italy's Mt. Etna.

Possibly more exciting, the Australian researchers are also building the infrared sensors into ash-spotting equipment they can install on aircraft. At a jet's cruising altitude, the device probably could spot an ash plume more than 80 km away, giving pilots more than enough time to divert their plane around the danger and warn other aircraft passing through the area. The prototype system is scheduled to be tested on a NASA aircraft later this year.

The potential market for such equipment is huge. As many as 300 flights per day between North America and Europe pass near Iceland, which has at least 70 volcanoes. A similar number of passenger or cargo jets fly over or near 100 Alaskan, Russian, and Japanese volcanoes on routes between North America and eastern Asia.

Onboard ash-plume sensors could provide aircraft and their passengers with extra protection. Says Prata: "With pilot reports [of volcanic plumes], ground-based sensors, and onboard ash-sensing equipment, we can pretty much solve the problem." ■

ALASKA VOLCANO OBSERVATORY

MEMORY ENHANCERS

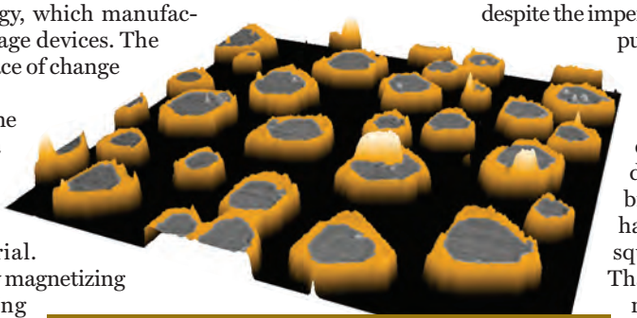
Researchers explore future possibilities for dense data storage

BY JESSICA GORMAN

Through engineers' never-ending quest for miniaturization, computers and other electronics keep getting smaller. But for many components, the rules change when their size approaches the nanoscale—where parts are just billionths of a meter across. Laws that rule in a gallon or a gram of material no longer apply. That's the dilemma for the makers of materials such as the iron oxide–coated disks in computer hard drives. These magnetic devices now store 30 million times as many bits of information per square inch as they did when introduced in 1956.

The most sophisticated magnetic recording devices have since gone from storing 2,000 bits of information per square inch to 60 gigabits per square inch, says Mark Kryder of Scotts Valley, Calif.,–based Seagate Technology, which manufactures hard disks and other storage devices. The question now is how long the pace of change can continue.

In particular, engineers face one looming obstacle: Once data storage increases to a certain density, ambient temperature can erase the information recorded on magnetic material. That's because data are stored by magnetizing tiny regions of the recording medium. The smaller the region, the less magnetic energy it contains, and the thermal energy at even room temperature can overwhelm the magnetism of a small region. When this happens, these regions "lose their magnetic memory," says Josep Nogués of the Catalan Institution for Research and Advanced Studies in Barcelona.



ISLAND ATTRACTION — A three-dimensional view shows one-atom-high magnetic islands with platinum cores (gray) and cobalt perimeters (orange).

S. RUSPONI ET AL./NATURE MATERIALS

Researchers need to come up with creative ways around this problem, which they call the superparamagnetic limit. In the near term, Kryder doesn't sound too worried. Companies that make these magnetic materials have developed or are pursuing promising new ways to keep the superparamagnetic limit at bay for at least several years. But what about after that?

"At some limit, you hit that wall," says Ivan K. Schuller of the University of California, San Diego.

Fortunately for everyone who wants faster and smarter computers, scientists are working on solutions. In recent tests, they've examined ways to reduce temperature effects on magnetic materials and gained insights into designing nanoscale data-storage materials that could be much more thermally stable than is now possible. They've also looked into ways to write and rewrite information to dense, thermally stable materials—a major challenge because of the large magnetic fields currently required.

This sort of basic research into magnetic materials may not show up in next year's personal computers, but according to scientists, it's the sort of fundamental work that could yield ideas that will govern your hard drive a decade from now.

SHORT-TERM MEMORY Information on hard drives or other magnetic media is stored in the form of bits representing 0s and 1s. An electromagnet records bits by magnetizing small areas of the crystalline film covering the disk. Essentially, each region is a tiny magnet with the north pole pointing either left or right, say, for a 0 or a 1.

As they make bits smaller to increase data density, engineers could make them stabler against temperature fluctuations by using materials that they can magnetize more intensely, notes Hideo Ohno of Tohoku University in Japan. But then it becomes more difficult to rewrite the bits, he says, because a stronger magnetic field is needed to change their orientation.

In the near term, data-storage density will continue to shrink, despite the impending superparamagnetic limit. To push that evolution as far as possible, Seagate, for one, has set out a road map for improving data density over the next decade. Although commercial materials today have data-storage densities up to 60 gigabits per square inch, the company has demonstrated 100 gigabits per square inch in its lab, says Kryder. That's using so-called longitudinal recording, the conventional technology, in which the magnetic orientations of bits lie in the plane of the disk.

As early as 2004, the company plans to roll out materials that use perpendicular recording, which magnetizes the film up and down rather than side to side. Because perpendicular bits pack together more tightly than do longitudinal bits of the same size, this technique should produce denser storage without sacrificing thermal stability, says Kryder. Within 6 years, he suggests, data density may increase to 1 terabit per square inch, which is 16 times what it is today.

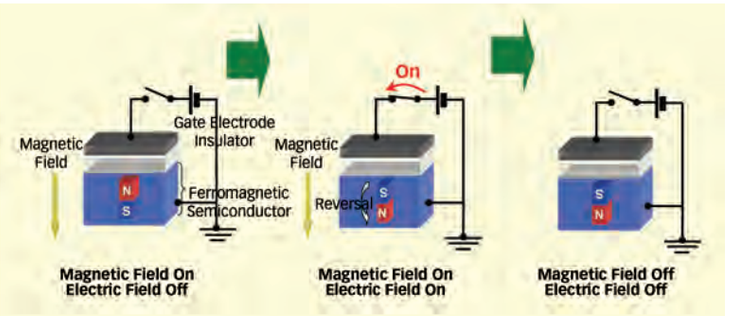
But even perpendicular recording will stave off the superparamagnetic limit only for a few years. At that point, researchers will again confront the need for new technology to increase storage density, and Seagate plans to turn to a technique called heat-assisted magnetic recording. In this approach, researchers use a laser to heat the exact spot where the magnetic field is applied while writing a 0 or 1.

This could enable researchers to work with materials that can support stronger magnetic fields than are now feasible and thus have higher magnetic energies. With current technology, rewriting bits on these materials requires an impractically large magnetic field. Laser heating, in effect, weakens the magnetization so that researchers can write and rewrite on these materials using a smaller

magnetic field. On removal of the laser heat, the material cools and is once again resistant to rewriting, so temperature fluctuations won't accidentally rewrite the bits. Researchers have already demonstrated heat-assisted recording's potential in the lab, says Kryder, although the technology isn't yet ready for the marketplace. He suspects that heat-assisted recording could carry magnetic materials to about 10 terabits per square inch.

Ohno is looking at an alternative to heat-assisted magnetic recording to get around what he says is the difficulty of localizing heat to sufficiently small areas. In experiments on manganese-doped indium arsenide—a magnetic semiconductor—Ohno and his coworkers apply an electric field to assist the magnetic field that's writing the 0 or 1. By doing so, the researchers report in an upcoming issue of *Science*, they can reduce the size of the magnetic field needed to rewrite a 0 or 1 on this magnetic semiconductor by 80 percent.

For now, Ohno says, "this is an experimental proof that there are means other than just heating the magnet to make them easier to . . . reverse magnetization direction, which may one day be useful for high-density magnetic-storage applications." The manganese-doped indium arsenide may not be the material that people use, he notes, because his experiments work only at temperatures below –223°C. Nonetheless, says Ohno, researchers may now find other materials or methods for using electric fields to rewrite bits at higher temperatures.



ELECTRIC ASSIST — In this schematic of a nanoscale piece of a hard drive, an applied magnetic field alone can't rewrite a bit of information. In the left image, the magnetic field within the semiconducting material remains north (N) up and south (S) down. But when an electric field (represented by top switch) supplements the magnetic field (center image), the bit changes magnetic direction. In the right image, with both magnetic and electric fields off, the bit holds its magnetic direction.

ISLAND DREAMS Magnetic media for data storage currently take the form of continuous films, but some researchers see advantages in making computer disks crammed instead with densely packed but magnetically isolated nanoparticles. Although this technology hasn't yet been demonstrated, Kryder speculates that these tightly packed islands could achieve data densities of 40 to 50 terabits per square inch. Nanoscale islands would still face problems because each one would have little magnetic energy and thus could be easily disturbed by the thermal energy at room temperature.

Nogués and his colleagues decided to see whether they could increase the thermal stability of nanoscale particles by constructing them on a special matrix. The researchers deposited 3-to-4-nanometer-wide cobalt particles onto a matrix of cobalt oxide. The latter is an antiferromagnetic material, meaning that neighboring atoms tend to align their magnetic orientations in opposite directions. In contrast, cobalt itself, like magnetic materials used to record data, is ferromagnetic, meaning that its atoms line up their magnetic orientations in the same direction.

Two years ago, Schuller and his colleagues suggested that antiferromagnetic materials might help stabilize nanoscale magnetic islands. In the June 19 *Nature*, Nogués' team reported that this is indeed the case. In the researchers' experiments, cobalt nanoparticles anchored in a ferromagnetic matrix held their magnetic information up to 17°C—nearly room temperature—while those in an ordinary, nonmagnetic matrix lost their orientations above the chilly temperature of –263°C. According to Nogués, the antiferromagnetic matrix increases the island's magnetic energy, so it can withstand more heat than if it were in another type of material.

The antiferromagnetic material in Nogués' experiment, cobalt oxide, is easy to study in the lab but wouldn't be useful for industrial applications since it loses its antiferromagnetic properties above 17°C, Nogués notes. He and his colleagues are now collaborating with Seagate scientists to identify other materials that retain their antiferromagnetism up to higher temperatures.

There's still a long way to go before nanoscale magnetic islands find their way into computers or other products, says Schuller. Numerous challenges remain. For example, companies will need a fast and cheap way to make the islands, he says.

Nonetheless, islands have become the focus of intense study. "A lot of people are quite interested in this research and how the properties of the nanoparticles are connected to their shape or size," notes Wolfgang Kuch of the Max Planck Institute for Mikrostrukturphysik in Halle, Germany.

In the August 2003 *Nature Materials*, for example, Harald Brune and his colleagues at the École Polytechnique Fédérale de Lausanne in Switzerland report different characteristics for interior and perimeter atoms in a single nanoscale magnetic island. Specifically, they studied the energy required to reverse the direction of an island's magnetization—a quantity that scientists technically call magnetic anisotropy energy. Brune and his coworkers deposited atoms of cobalt on a platinum surface, forming islands of various sizes. When they analyzed the contribution of the individual atoms to the magnetic anisotropy energy, the researchers found that the perimeter atoms have the largest influence on the phenomenon. Therefore, an island's magnetic anisotropy energy isn't proportional to the area of the island, says Brune, but rather to the number of atoms around its rim.

To check these findings, he and his colleagues also made nanoscale islands with a perimeter of cobalt atoms surrounding a platinum interior. These islands, the researchers report, had the same magnetic anisotropy as did islands made entirely of cobalt, as long as both had the same number of perimeter atoms.

Kuch comments that work by Brune and his colleagues suggests a way to tailor the magnetic anisotropy and other properties of magnetic materials very precisely. By placing certain atoms at an island's perimeter and others in its interior, engineers could make islands that behave exactly as they want.

However, Brune's research is still very fundamental, Kuch cautions, and the materials used by the team aren't commercially useful since the team performed their measurements at the uncomfortably cold temperature of –223°C.

Moreover, "one never knows what will happen in the future, and maybe some completely different technology will take over before magnetic-data storage comes to the point where one nanoparticle is one single bit," says Kuch.

Yet down the road, the basic research coming out of academic research centers could help computer-disk makers reach the 40-to-50-terabit goal that Kryder proposes. Such fundamental research is important because, Schuller says, "this produces the ideas that will lead to the useful things."

Publicly reported university research in this field is rarely ready for prime time, Schuller adds, while companies that have a new data-storage material will put it in a computer before anyone knows about it. He says, "Before you read about it in some science journal, you're going to buy it." ■

OHNO

OF NOTE

ENVIRONMENT

Exposure to phthalate may shorten pregnancy

Babies exposed to a common plasticizer before birth spend a week less in the womb than do those without evidence of exposure, researchers have found.

In their study, pediatrician Giuseppe Latini of Perrino Hospital in Brindisi, Italy, and his colleagues tested blood from 84 newborns' umbilical cords for the presence of di-(2-ethylhexyl)-phthalate (DEHP) and mono-ethylhexyl-phthalate (MEHP). The body converts DEHP, an ingredient in plastics used to make toys and wrap foods, into MEHP.

The researchers looked for relationships among factors that included blood concentrations of the phthalates, the pregnancy's duration, and the infant's birth weight.

In an upcoming *Environmental Health Perspectives*, the researchers report that the 65 newborns in the study who had detectable blood concentrations of MEHP were born after an average of 38.2 weeks in the womb. The 19 infants without detectable MEHP concentrations were born an average of 39.4 weeks after conception.

The researchers didn't find statistical evidence of a relationship between MEHP and low birth weight or any other deleterious outcome, however. —B.H.

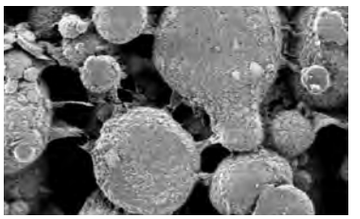
CHEMISTRY

Secret of strong silk

How spiders and silkworms manage to produce strong fibers without clogging their silk-producing glands has puzzled scientists for years. While trying to mimic the process in the lab, researchers at Tufts University in Medford, Mass., stumbled across the answer.

David Kaplan and Hyoung-Joon Jin took natural silk from a silkworm, extracted the silk proteins known as fibroins, and dissolved them in water. The researchers then added increasing amounts of polyethylene oxide, a polymer that gradually removed water from the solution. As water volume decreased and the concentration of fibroin increased, the proteins folded in on themselves, forming round structures called micelles. Measuring between 100 and 200 nanometers in diameter, each micelle had a hydrophobic (water-avoiding) interior and a hydrophilic (water-seeking) surface.

In the Aug. 28 *Nature*, Kaplan and Jin explain that this micelle structure enables the fibroins to remain soluble in water. That prevents the proteins from crystallizing prematurely and gumming up the bugs' silk-producing glands. As the polyethylene oxide drew more water out of the fibroin solution, the micelles aggregated into microscopic globules. When Kaplan and Jin analyzed the glands of silkworms and their fibers, they found similar structures.



TOUGH STUFF Silk proteins assemble into globules before being spun.

The combination of the tightly bound micelle nanostructures and the microscale globules is what gives the silk its strength, says Kaplan. Although many companies have produced silk fibers in the lab, the synthetic strands don't match the strength of natural fibers. Kaplan says he hopes his work will help industry move closer to that goal. —A.G.

PALEOBIOLOGY

Fossils' ear design hints at aquatic lifestyle

One of Earth's earliest-known four-limbed creatures—long thought to have been a land dweller at least part of the time—could hear best when it was underwater, according to new studies of fossilized skulls.

Remains of *Ichthyostega*, a stout-limbed tetrapod that lived about 360 million years ago, were first described by scientists in the 1930s. Despite decades of analyses of many fossils, several features of the creature's skull and ear region have remained enigmatic. Some characteristics, including two large, bony chambers near the rear of the animal's head, are found only in *Ichthyostega*, says Jennifer A. Clack, a paleontologist at the University Museum of Zoology in Cambridge, England.

She and her colleagues used several techniques, including computer-aided-tomography scans, to scrutinize some long-studied *Ichthyostega* fossils, as well as finds unearthed in 1998. During their analyses, the scientists realized that previous investigators had misidentified a delicate, cup-like feature that projects into each of the chambers at the rear of the creature's head. That bone turned out to be the stapes, which transmitted vibrations to the animal's inner ear.

Clack and her team suggest that each stapes was embedded in a membrane that sealed the air-filled chamber. As a result, the air bubble housed in each cavity would pulsate in response to sound waves, causing the membrane to oscillate and enabling the animal to hear. That design would have detected sound best when *Ichthyostega* was immersed in water, an indication that the animal may have spent more time in the water than scientists previously suggested, the researchers report in the Sept. 4 *Nature*. —S.P.

BIOMEDICINE

Grades slipping? Check for snoring

Children who snore frequently are more likely to struggle with their schoolwork than are children who rarely snore, researchers in Germany report in the August *American Journal of Respiratory and Critical Care Medicine*.

The scientists asked parents of 1,129 third-graders to rate their children's snoring as occurring always, frequently, occasionally, or never. The researchers then compared each child's snoring frequency with his or her academic performance.

Children who always snored were roughly four times as likely to perform poorly at math, science, and spelling as were children who never snored. Poor math and spelling grades also plagued children who snored frequently. Those who snored occasionally didn't have any more academic problems on average than did kids who never snored.

Most likely, snoring causes "repeated arousal" during the night and leaves some children tired in the morning, says pediatrician Christian F. Poets of the University Hospital of Tübingen in Germany.

He and his colleagues tested for another common sleep disorder—intermittent hypoxia, or low blood oxygen—by having the children wear a sensor on a finger overnight. Children showing evidence of nighttime hypoxia, which can accompany snoring, didn't fare worse in school than their fellow students did. That result suggests that the academic problems of heavy snorers in the study arose from sleepiness at school, not oxygen deprivation during

NATURE

OF NOTE

the night, Poets says.

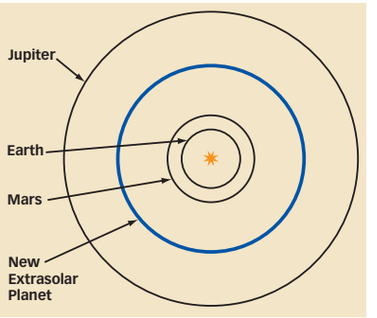
One message of the study, he adds, is that parents should mention habitual snoring in their children to doctors. In some cases, surgical removal of tonsils or adenoids can relieve the problem. —N.S.

ASTRONOMY

Solar system replica?

Looking at a star 90 light-years away, astronomers have found what may be the closest analog known to our solar system. By recording the motion of the sunlike star HD 70642 for 5 years, scientists have discerned that an unseen planet at least twice as massive as Jupiter is tugging on it.

Like Jupiter, this extrasolar planet lies billions of miles from its parent star. It shares another important property with Jupiter: Its orbit is nearly circular, a rarity among planets that lie relatively far from their parent stars. Simulations show that outer planets with such a trajectory are conducive to the survival of inner planets that could harbor life.



JUPITER ANALOG Orbit of the newly found extrasolar planet, depicted relative to the orbits of Mars and Jupiter in our own solar system.

In contrast, massive outer planets with elongated orbits act like gravitational slingshots that are likely to eject an inner planet that's on an Earthlike path, notes Hugh R.A. Jones of the Liverpool John Moores University in England. An inner planet that did manage to stay in orbit would have its path elongated by the interaction, subjecting the body to huge temperature swings. Such variations would make it much less likely that life could survive.

Jones and his colleagues report their findings in the Aug. 10 *Astrophysical Journal Letters*.

John E. Chambers of NASA's Ames Research Center in Moffett Field, Calif., cautions that if the newfound planet is either much heavier than its known minimum mass or if the star is host to another massive planet, an inner Earthlike planet could still be ejected from the system. Nonetheless, this system is "one of the best places to look [for an Earthlike body] among the planetary systems we know of," he says. —R.C.

EARTH SCIENCE

New mantle model gets the water out

Between our planet's crust and its core lies the mantle, a realm where solid rock oozes under pressures millions of times as great as that exerted by the atmosphere. Although some scientists hold that the entire mantle gradually mixes, others suspect that the mantle's deeper rock—and the trace elements it contains—typically doesn't get too close to Earth's crust, says geophysicist David Bercovici of Yale University. The limited-circulation scenario stems from the observation that the molten rock oozing from midocean ridges lacks much of the uranium, thorium, and other trace elements that spew from some aboveground volcanoes. The volcanoes are fueled by so-called hot-spot plumes that originate lower in the mantle than do areas feeding the ocean ridges.

Bercovici and his Yale colleague Shun-Ichiro Karato propose that when slow-rising mantle rock reaches within 400 kilometers of Earth's surface, the material sheds much of its water and partially melts. During that process, the scientists surmise, most trace elements leach out of the rock. This occurs mostly within a 10-km-thick layer of the mantle, and the resulting liquid later circulates back toward the planet's core.

Because mantle material in the hot-spot plumes rises quickly through the thin layer where leaching occurs, it doesn't lose as many of its trace elements as slow-rising rock does. The researchers describe their model in the Sept. 4 *Nature*. —S.P.

BIOMEDICINE

Coronary calcium may predict death risk

A computerized X-ray image of calcium deposits along a person's coronary arteries can signal whether that individual carries a hidden health risk, a study in the September *Radiology* suggests.

Researchers enrolled 10,377 people, average age 53, who were free of heart disease but had at least one risk factor for it. These included high cholesterol, a family history of early heart problems, high blood pressure, a smoking habit, and diabetes. All participants received a computerized tomography scan of their coronary arteries.

For each person, the researchers created what they called a coronary calcium score on the basis of the size and density of calcium deposits revealed by the scan. Most volunteers had a score of less than 10, but some exceeded 1,000, says study coauthor Paolo Raggi of Tulane University in New Orleans.

After tracking the participants for an average of 5 years, the researchers found that people with calcium scores of 100 to 400 at the beginning of the study were nearly four times as likely to have died than those with scores under 10. The 3 percent of volunteers with scores over 1,000 were 12 times as likely to be dead after 5 years, compared with the low-calcium group.

Coronary calcium scores might prove valuable for identifying people who have no symptoms of heart disease but are at risk of it, Raggi says. —N.S.

INFECTIOUS DISEASES

Control of animal epidemic slowed human illness

Control measures implemented in response to a 2001 outbreak of foot-and-mouth disease among livestock in England and Scotland apparently helped reduce by a third the incidence that year of a parasitic illness in people, researchers in Scotland have found.

To stamp out the foot-and-mouth outbreak, officials sacrificed more than 1 million sheep and cattle in the affected areas of Scotland and restricted the transportation of other animals. Regulations also prevented people from making unnecessary visits to farms.

Those measures apparently slowed the spread of *Cryptosporidium parvum*, a diarrhea-causing parasite that can spread from farm animals to people via water or soil tainted with feces. In Scotland's foot-and-mouth–affected areas, 60 percent fewer *Cryptosporidium* infections occurred in people than was the yearly average from 1994 to 2000, Norval Strachan of the University of Aberdeen and his colleagues report in the September *Journal of Infectious Diseases*. There wasn't a significant fall in *Cryptosporidium* incidence in areas of Scotland free of foot-and-mouth disease, where the response to the outbreak was less aggressive.

The restoration of good livestock health had a predictable side effect: *Cryptosporidium* infections rebounded in Scotland in the year following cessation of outbreak-control measures. —B.H.

PPARC

Books

A selection of new and notable books of scientific interest

BUTTERFLIES OF NORTH AMERICA

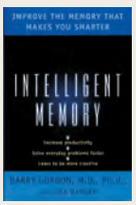
JIM P. BROCK AND KENN KAUFMAN

Hundreds of species of butterflies flutter around North America without much notice. In a stirring introduction, Kaufman challenges readers to start looking for them. In the rest of the book, he and lepidopterist Brock present a handy, fully illustrated guidebook to butterflies. Entries clearly define each specimen's territory, favorite plants, and active season. More than 2,300 photographs and illustrations show back and side views of males, females, and larvae and indicate specimens' sizes. The authors also reveal tips for identifying each butterfly described. ***HM, 2003, 383 p., color photos/illus., flexibind, $22.00.***

INTELLIGENT MEMORY: Improve the Memory that Makes You Smarter

BARRY GORDON AND LISA BERGER

Gordon, the founder of the Memory Clinic at Johns Hopkins Medical Institutions, teams with science writer Berger to impart an understanding of how memory works and how it may be improved. The authors focus on "intelligent memory"—the memory that melds thinking and the ordinary remembering of specific facts to create critical thinking. Intelligent memory is what fails us when we don't feel as clever as we would like. Gordon argues that there is little direct connection between remembering facts and being intelligent. On the other hand, he asserts that intelligent memory can be strengthened and improved by experience, even in old age. This book is a combination of practical quizzes and memory exercises based on Gordon's research. ***Viking, 2003, 219 p., hardcover, $24.95.***



LOWLY ORIGIN: Where, When, and Why Our Ancestors First Stood Up

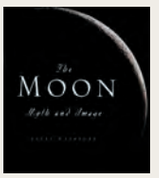
JONATHAN KINGDON

Bipedalism makes us distinctly human. It enables us to cross wide-open spaces, manipulate complex tools, and light fires. Kingdon melds evidence from the fossil record with a survey of fields including ecology, biogeography, and paleontology to explain what it took to get our ancestors up on two legs, as well as the consequences of those first steps. This book presents evidence that no fewer than 20 species of hominids have lived and become extinct. In considering this "bewildering diversity," Kingdon asks how modern humans came to dominate the species that dropped off along the way. With a clear emphasis on biogeography, Kingdon breaks down some of the major developments in evolution according to time and place, such as when our ancestors first ate fruit or lost their tails. ***Princeton U Pr, 2003, 396 p., b&w photos/illus., hardcover, $35.00.***

THE MOON: Myth and Image

JULES CASHFORD

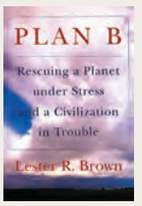
Telling stories about the moon began as an ancient activity. Lunar images appear in the earliest rock carvings, and they still fascinate us. Cashford explores the myths, symbols, and poetic musings inspired by the moon, from Paleolithic times to the modern day. The story outlines our profound relationship with the moon and its influence on the tides, our calendar, and our understanding of the cycle of life. Cashford traces secular customs back to their sacred, lunar source, as interpreted by human thought. This book combines scores of images with a rich tapestry of myth and history to provide a unique view of our neighbor in space. Originally published in Britain in 2002. ***FWEW, 2003, 399 p., hardcover, b&w photos/illus., hardcover, $25.95.***



PLAN B: Rescuing a Planet under Stress and a Civilization in Trouble

LESTER R. BROWN

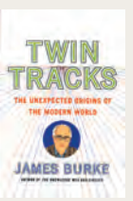
Environmental analyst and founder of the Earth Policy Institute, Brown sounds the alarm about a food supply that's shrinking because of overharvesting and water shortages. Brown reports that China's grain harvests have fallen from 392 million tons in 1999 to 340 million tons in 2003 as a direct result of drought and depletion of aquifers. He argues that the effect will be increased food costs and, ultimately, global political instability. In these pages, he outlines an agenda for stabilizing the world's population, reducing industrial and automotive carbon emissions, and raising water productivity. Brown calls attention to a threat he considers just as severe as terrorism and urges governments to create a more sustainable worldwide economy. ***Norton, 2003, 285 p., paperback, $15.95.***



TWIN TRACKS: The Unexpected Origins of the Modern World

JAMES BURKE

Right now, someone unknown to you is doing something that will bring change to your life. You will do the same to others. This isn't fortune cookie philosophy. It's a systems approach to understanding history. Burke, a contributor to *Scientific American,* is fascinated with unintended consequences. Until recently, most people viewed history as a string of distinct events falling within independent themes. With the ability to gather and cross-reference immense amounts of data, scientists and historians can now track outcomes back to causes and intervening circumstances. For example, Burke links the opening of the Kit-Kat Club in London in 1703 to the advent of sunglasses in 1930, and the invention of Sanskrit to the creation of cybernetics. He shows how 25 of the most important artifacts of modern civilization grew out of unexpectedly cross-fertilized ideas. Each chapter begins with an event from the past and proceeds along two parallel historical paths to converge on a discovery years later. ***S&S, 2003, 276 p., hardcover, $24.00.***



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LETTERS

Take flight

With the facts as given in "Flight burns less fuel than stopovers," (*SN: 7/12/03, p. 29*), the birds spent about 7 percent of their time flying and 93 percent not flying. At the energy rates given, I get that 25 percent of the energy used was spent during the 7 percent of time the birds were flying. The article appeared to state that somehow flying was more energy-efficient than resting, but the flight portion measured was only 4.6 hours long and the nonflight days were 24 hours long, so they weren't comparable.

ELIZABETH OSCANYAN, PHILOMONT, VA.

Your facts are right, but this study looks at energy budgets, not energy efficiency. The total energy spent at stopovers was greater than the total spent flying. —S. MILIUS

Near and far

Although I was thrilled, as usual, to hear of yet another discovery that might lead us to our brethren in the universe ("Record Breaker: A planet from the early universe," *SN: 7/12/03, p. 19*), I was dismayed to learn that our scientists have been in such disagreement about the requirements for planetary existence. It made me worry about how many other "requirements" they may have all wrong.

JOYCE STILLMAN, ODESSA, N.Y.

The article describes the oldest planet known in the universe, about 12.5 billion years old, to be 7,200 light-years from Earth. Doesn't that contradict Hubble's law, which states that distance is correlated with age?

JEFFREY FREED, TACOMA, WASH.

No, old objects can be nearby or far away. The object is seen as it was 7,200 years ago, but at that time, the star and the globular cluster that it's in were already quite ancient. —R. COWEN

Questions, questions

"All the World's a Phage" (*SN: 7/12/03, p. 26*) raised so many questions. Do children who play in the dirt get their increased immune resistance from phages in the dirt? Is there a phage connection in the AIDS story? Does the risk of dying of heart attacks have a phage connection? If so, is group A *Streptococcus* involved? Do we need a new major scientific effort to identify the next million or billion phages? How are the phage populations different from the ocean to beach to city to farm to forest? The article was one of the most intriguing and provocative in recent history.

JOHN HARDEN, KIRKLAND, WASH.