FEBRUARY 24, 2007 PAGES 113-128 VOL. 171, NO. 8

THE WEEKLY NEWSMAGAZINE OF SCIENCE

pollock's fractal fracas a better fix for knees planets' extrasolar spectra jays plan next meal

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THE LIGHT AND THE DARK

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SCIENCE NEWS FEBRUARY 24, 2007 VOL. 171, NO. 8

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Cover Astronomers assembled this three-dimensional map of the cosmos' invisible dark matter by analyzing data from the largest survey of galaxies ever conducted with the Hubble Space Telescope. A separate, ground-based survey traces the growth of galaxies since the universe was half its current age. (Scoville *et al.*/NASA) Page 120

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SCIENCE NEWS This Week

Alien Light

Taking the spectra of extrasolar planets

Astronomers have for the first time recorded the spectra of light emitted by two extrasolar planets. This achievement provides a new, direct way to analyze the atmosphere of alien worlds light-years from Earth.

Obtained by NASA's Spitzer Space Telescope, the infrared spectra represent a milestone in the study of distant planets, says David Charbonneau of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Both planets show a puzzling lack of water vapor, he adds.

Charbonneau and members of two other teams reported the findings during a NASA briefing this week.

Spitzer recorded spectra both when the planets were behind their respective stars and when they passed in front of them, as seen from Earth. For each system, subtracting the spectrum of the star from that of the star and planet together yielded the spectrum of the planet.

Astronomers had previously used a subtraction method to measure the overall infrared glow of two extrasolar planets (*SN: 3/26/05, p. 195*). Four years earlier, researchers had recorded the intensity of a single wavelength of starlight that filtered through the atmosphere of one of the planets featured in the current reports. That team determined that the planet's atmosphere has only a low concentration of sodium (*SN: 12/1/01, p. 340*).

The new findings are the first to analyze, wavelength by wavelength, the infrared radiation, and therefore heat, emitted by extrasolar planets, notes Jeremy Richardson of NASA's Goddard Space Flight Center in Greenbelt, Md. He and his colleagues examined the hot, Jupiterlike planet HD 209458b about 153 light-years from Earth. They describe their findings in the Feb. 22 Nature.

Another team, led by Mark R. Swain of NASA's Jet Propulsion Laboratory in Pasadena, Calif., analyzed the same data independently. A third team, which includes Charbonneau, took spectra of another hot



OBSCURED ORB Clouds may sheathe the atmosphere of some extrasolar planets, masking the presence of water vapor at lower altitudes, as in this artist's depiction.

Jupiter, the planet HD 189733b, which lies 62 light-years from Earth. Charbonneau and his colleagues describe their findings in an upcoming *Astrophysical Journal Letters*.

The spectrum of each planet shows no sign of water vapor. That's surprising, notes theorist Jonathan Fortney of NASA's Ames Research Center in Mountain View, Calif., because scientists had expected hydrogen and oxygen atoms in the atmospheres of these hot planets to readily combine into water. Water is abundant in the atmosphere of brown dwarfs, or failed stars, which are the bodies most resembling hot Jupiters, he adds.

Richardson's team, which reports hints of silicates in the atmosphere of HD 209458b, proposes that high-altitude silicate clouds may mask water vapor at lower altitudes. But Swain and his collaborators find no evidence of silicates in the same data, and Charbonneau's team sees no sign of silicates in the spectra of HD 189733b.

Fortney says that if the atmosphere of the extrasolar planets has the same temperature throughout—unlike the atmospheres of Earth, Saturn, or Jupiter—water vapor or other compounds wouldn't be evident in the spectrum.

Another possibility, he notes, is that intense ultraviolet light bombarding the close-in planets from their stars generates high-altitude clouds of unknown composition. Those clouds would absorb infrared light over a wide range of wavelengths and mask underlying water vapor and other molecules. Sodium in the atmosphere of HD 209458b might also be obscured by such clouds, Fortney says.

Additional Spitzer observations of the planets, Swain says, should solve the mystery of the missing water vapor. —R. COWEN

Weight Matters

Big and little mouse pups become obese adults

Being either overnourished or undernourished before birth can alter gene activity, leading to obesity during adulthood, a study in mice suggests. The researchers predict that this finding could lead to more-tailored treatments for obesity in people.

Some scientists have proposed that obesity and a variety of diseases result from the conditions in which fetuses develop. To determine whether fetal changes in gene activity could initiate obesity, Frederick vom Saal of the University of Missouri–Columbia and his colleagues removed a single ovary from female mice. When these mice became pregnant, the eight or so fetuses that typically occupy both tubes of the mothers' uteruses crowded into a single tube.

Vessels that feed into both ends of each tube of a mouse uterus supply it with the mother's blood. Therefore, in the experiment, fetuses stuffed into the middle of the single uterine tube received less nourishment than fetuses at either end did. Those

JPL-CALTECH/NASA

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at either end of the tube were unusually heavy at birth, and those in the center of the tube were unusually light. Fetuses located at intermediate positions were born at normal weights.

As the baby mice grew into adults, vom Saal's team found that the normal-weight babies typically became normal-weight adults and that the big babies became obese adults. Babies born light quickly became just as heavy as the obese babies and kept that extra heft into adulthood, the researchers reported last week in San Francisco at the annual meeting of the American Association for the Advancement of Science.

When the researchers analyzed gene activity in fat samples from the adult obese mice, they found 435 genes that were more active in one of the groups of obese mice than in the other. In most cases, these genes controlled metabolic activities, such as creating fat cells or regulating the cells' uptake of energy-storing lipid molecules.

The results suggest that the amount of nutrition that the fetuses received permanently affected how their genes functioned, vom Saal notes. However, he adds that differing gene activity between the low- and high-birthweight groups suggests that their obesity stemmed from separate mechanisms, which haven't been mapped out.

"To really understand a person's obesity, we might have to go back in time to see how their genes were originally programmed," vom Saal says. Once researchers pinpoint a person's cause of obesity, they may be able to design a specific treatment.

Retha Newbold of the National Institute of Environmental Health Sciences in Research Triangle Park, N.C., who studies how chemical exposures can influence obesity, notes that vom Saal's work strengthens the link that previous studies have found between fetal environment and disease. "It may not be that we are all just what we eat and what we burn. Our exposures during development may be playing a role in how we develop obesity," she says. —C. BROWNLEE

Hurt-Knees RX Surgical method promotes ligament regeneration

Artificial knee ligaments incorporating live cells led to growth of new ligament tissue in recent experiments in rabbits. The technique could eventually provide an alternative surgery for athletes and others with knee injuries.

Each year, more than 200,000 people in the United States experience tears to a knee ligament called the anterior cruciate ligament, or ACL. Damaged ligaments heal poorly if at all, so in the standard repair for ACL injuries, a surgeon cuts a piece of healthy ligament from another part of the patient's leg and uses it to replace the torn ligament. But harvesting the healthy ligament can cause long-lasting pain and limit leg function.



NEW GROWTH Ligament (arrow) is vulnerable to damage in the human knee (top). Cross-section of a recently developed artificial ligament (bottom) 12 weeks after surgery shows new ligament tissue (green indicates collagen, purple indicates cells) filling the spaces between the polymer threads (white) of the implant.

The new artificial ligament, developed by Cato T. Laurencin of the University of Virginia in Charlottesville and his colleagues, may eventually enable doctors to avoid the extra surgical step.

"The hope is to make the ACL reconstruction a simpler procedure where we would move away from having to harvest the tissue," Laurencin says.

Surgeons have inserted synthetic replacement ligaments into people, but these implanted prosthetics often break. "The problem with a prosthetic is that, over time, the prosthetic will eventually fail because it doesn't regenerate," Laurencin says.

To promote regeneration of ligament tissue, Laurencin and his colleagues worked with rabbit-ligament cells. Those cells generate new tissue only when they're embedded into a specific kind of scaffolding. The researchers created a braided mesh with the right pore size—about 200 micrometers—by weaving together strands of a polymer called polyL-lactide.

When they implanted the cell-carrying polymer into knee joints of six rabbits, the scientists found substantial regeneration of ligament tissue after 12 weeks. Because the polymer is biodegradable, new ligament slowly replaces the prosthetic.

"This is the first technique that [in animals] has demonstrated such a remarkable level of ligament regeneration," Laurencin says. Twelve weeks after surgery, the implants supported about 30 percent as much tension as an uninjured ligament does. That measurement compares favorably with that observed for the current standard surgical technique, which restores about 15 percent of normal strength in a similar time period, the researchers report online and in an upcoming *Proceedings of the National Academy of Sciences*.

"I think it's a good first step, but there are certainly some major challenges ahead before something like this can be approved," comments Steven D. Abramowitch, a bioengineering professor at the University of Pittsburgh. Half the rabbits eventually suffered ruptures in the implants, but Laurencin notes that the animals moved around freely after surgery and didn't stay off the repaired knee or do rehabilitation, as a human patient would.

Laurencin says that the next step in developing a clinical procedure will be to do longer trials in rabbits that include rehabilitation. —P. BARRY

Virus Stopper Herpes drug dampens HIV infection

An antiviral drug commonly taken for genital herpes seems to suppress HIV, the AIDS virus, in people harboring both pathogens, a study in West Africa finds. The report bolsters the notion that the two viruses have some biological interplay and suggests that herpes drugs might slow the spread of HIV.

Researchers identified 136 women in Burkina Faso who were infected with both genital herpes and HIV. The AIDS virus hadn't depleted immune cells in any of these women enough to make them candidates for drug treatment, and none was receiving any herpes drug. The researchers randomly assigned half the women to receive the herpes drug valacyclovir in daily pills and the other women to get a placebo. Physicians examined the volunteers over the subsequent 3 months, taking vaginal and cervical swabs, and obtained blood samples every other week.

Women getting valacyclovir were less than half as likely as the others to have HIV show up in genital-tract swabs. Participants receiving the drug also had significantly less HIV in their blood, epidemiologist Nicolas Nagot of the London School of Hygiene and Tropical Medicine and his team report in the Feb. 22 *New England Journal of Medicine (NEJM)*.

Those two findings suggest that herpes treatment "is likely to reduce HIV progression in [dually] infected people as well as reduce the likelihood of HIV transmission to uninfected partners," says Ronald Gray, a physician and epidemiologist at Johns Hopkins Medical Institutions in Baltimore.

Scientists cite two mechanisms by which herpes might exacerbate an HIV infection, and hence envision how curbing herpes would slow the course of HIV.

Proteins that form part of the herpesvirus structure may "activate HIV-replication genes, a sort of viral-viral interaction," Nagot says. Herpes proteins seem to reawaken HIV and probably contributed to the higher blood concentrations of HIV in untreated people in the new study, physician Lawrence Corey of the University of Washington in Seattle says in *NEJM*.

Other evidence suggests that the inflammatory reaction triggered by a herpes infection causes white blood cells to rush to herpes-and-HIV-infected tissue. That influx includes CD4 T cells, immune cells that HIV infects. Suddenly, "you've got more HIV targets," Gray says.

The result is a depletion of these immune cells. Earlier work showed that HIV-positive people who are also infected with tuberculosis decline faster than those not dually infected, apparently because CD4 T cells were exposed to HIV as they fought the TB microbes. By the same token, past work has shown that men dually infected with HIV and gonorrhea or chlamydia have less HIV in their semen when treated with antibiotics that fight the bacteria.

The new study "has direct clinical implications, suggesting that HIV replication can be reduced with antiviral therapy directed solely at [genital] herpes," Corey says.

Study participants getting valacyclovir shed less HIV from their genital tissues than did women not getting the drug, but "whether this translates into a reduction of transmission is unclear," Nagot says.

The question might be answered by an ongoing study of couples in which one person has HIV and herpes and the other is HIV negative. Scientists are seeking to determine whether treatment for herpes affects transmission between individuals. —N. SEPPA

Bird Plans Jays show foresight in breakfast menus

The strongest evidence yet that animals plan ahead may come from western scrub jays preparing for their morning meals.

Plenty of animals perform actions that bring future benefits, but those activities don't necessarily demonstrate planning, says Nicola S. Clayton of the University of Cambridge in England. Smart moves may be just responses to cues, either innate or learned. Geese don't necessarily plan when they fly south as winter approaches. And a cat may have learned that the sound of a car in the driveway means food will soon appear in its bowl.



THINKING ABOUT TOMORROW A western scrub jay caches food where experience indicates that it won't otherwise be available the next day.

Researchers cite planning only when an animal acts to satisfy a future need that's different from its current one. A cat lurking by a mouse hole is already hunting, not planning for a future hunt.

Now, though, Clayton and her colleagues say that they've found scrub jay behavior that qualifies as planning. In a lab setup, scrub jays cache food in places where they have previously been stuck without any breakfast. The birds also cache particular kinds of food in places that hadn't provided them, Clayton and her colleagues report in the Feb. 22 *Nature*.

The jay results are the first in any animal that "unambiguously" meet the criteria for planning, comments comparative psychologist Sara Shettleworth of the University of Toronto. In the wild or the lab, scrub jays bury nuts (*SN: 5/20/06, p. 309*). To prepare the birds for the test, Clayton and her colleagues housed jays in suites with two annexes. Researchers pulverized food provided to the jays during this initial phase to prevent them from caching it. On some mornings, the researchers confined a bird in one of the annexes for 2 hours with no breakfast. On other days, the researchers kept the bird in the other annex, which had food available. Thus, the birds had information about where food would be available in the mornings.

For the test, researchers served whole pine nuts to the jays on a single evening. The birds could eat their fill of the nuts and still cache extras in either annex. The eight scrub jays in the test deposited most of their cache in the no-breakfast annex.

In a second experiment, Clayton and her colleagues during mornings served peanuts in one annex and kibble in the other. When the researchers offered the birds a chance to cache the foods in either place one evening, the jays put more of each food in the compartment that had lacked it. This shows that the birds planned to have the missing alternative food for a later meal, say the researchers.

This is the first test of animal planning "to make a strong case," says Thomas Suddendorf of the University of Queensland in St. Lucia, Australia. He has been critical of earlier experiments with other animals. He does caution—and Clayton agrees—that the results don't show whether scrub jays plan the way people do, with imaginary time travel into the future. —S. MILIUS

Decoding Autism

Study finds DNA clues to developmental disorders

New results from the largest study of its kind direct the search for autism-influencing genes to a previously overlooked DNA segment and highlight the role of a crucial chemical-messenger system in creating brains susceptible to autism.

Genetic analyses of 1,168 families, each containing two or more persons with autism or a related condition, indicate that as-yet-unidentified genes on part of chromosome 11 often contribute to the developmental disorders. A group of more than 120 scientists in 19 countries report the findings online and in an upcoming *Nature Genetics*. Previous studies of fewer people with autism (*SN: 10/21/06, p. 259*) had identified a potential autism gene but missed the genetic link to chromosome 11.

That DNA location and several others

CLAYTON LAB

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linked to autism in the new study harbor genes for proteins that shuttle glutamate among brain cells. That chemical messenger stimulates neural activity and influences brain development.

Report coauthors Bernie Devlin of the University of Pittsburgh and Stephen W. Scherer of the University of Toronto and others now plan to look for links between variants of glutamate-related genes and autism in the families.

"It is likely that a number of autism genes will be identified in the next couple of years," says psychiatrist and study coauthor Joachim Hallmayer of Stanford University.

The new data reveal autism-linked chromosome alterations in 7 to 12 percent of the families, depending on whether the disorder was defined narrowly or broadly. These DNA modifications included deletions and repeated short sequences.

In one family, for instance, only individuals with autism displayed a particular deletion on a chromosome 2 gene known as *neurexin 1*. Other studies have indicated that *neurexin 1* fosters glutamate's movement from one brain cell to another.

Boys display autism and other developmental disruptions of language and social relations far more often than girls do. Consequently, earlier genetic studies of autism had focused on boys. In the new study, more than one-third of the families included girls diagnosed with these disorders.

When the analysis included families with affected girls, the evidence linking genes on chromosome 11 and in other DNA areas to autism became much stronger than when only affected boys were considered.

Neuroscientist Matthew Belmonte of Cornell University regards the new chromosome 11 finding as "especially interesting." Much evidence had already indicated that females who develop autism have, on average, more of the known genetic and environmental risks for the disorder than males do, he notes. So, males seem more susceptible to autism.

The chromosome 11 region identified in the new study deserves scrutiny for genes that contribute to autism, particularly in girls, Belmonte says.

The autism-related deletion in the *neurexin 1* gene, although limited to one family in the new study, should be explored in further investigations, he adds. Increasing evidence suggests that variations in a family of genes that includes *neurexin 1* disturb the delicate balance between substances that amplify and quell neural activ-

ity as the brain grows. Belmonte suggests that the resulting neural imbalance may trigger patterns of brain development that foster autism. -B. BOWER

Warming Sign?

Larger dead zones form off Oregon coast

Unprecedented recent changes in the yearly pattern of ocean currents off North America's West Coast have wreaked havoc on aquatic ecosystems there. Those changes, which have triggered the formation of large areas of oxygen-poor water along the Oregon shore, may be a troubling symptom of Earth's warming climate, a group of scientists says.

Fisheries along the western coasts of North America, South America, and Africa account for less than 1 percent of the world's ocean area but produce more than 20 percent of its wild-caught fish. In those areas, winds that blow toward the equator at certain times of the year bring cool, nutrient-rich waters to the coastal shallows, says Jane Lubchenco, a marine biologist at Oregon State University in Corvallis. In the past few years, however, productivity of some species has decreased precipitously, she and her colleagues reported last week in San Francisco at the annual meeting of the American Association for the Advancement of Science.

For example, large areas of oxygen-poor water, often called dead zones (*SN: 6/5/04, p. 360*), now form each summer off Oregon. Such zones first appeared in 2002, but during the past 2 years, they were longer lasting than before and had lower oxygen concentrations, says Lubchenco.

John A. Barth, a physical oceanographer

at Oregon State University, notes that in 2005, the annual onset of southerly winds off the Oregon coast was delayed from mid-April to mid-May. Lacking their usual input of nutrients, the plankton at the base of the region's aquatic food chain didn't thrive, and many plankton-eating creatures starved. When the winds finally kicked in, they brought an excess of nutrients that fed profuse, widespread blooms of algae that later died and decomposed, robbing the water of oxygen.

That double whammy of starvation and suffocation struck ecosystems hard, Barth reports. For instance, the number of young barnacles that he and other scientists found off the Oregon coast between June and August 2005 was 34 percent of normal. The tally of young mussels ended up at 17 percent of average in other years. Underwater cameras showed large numbers of dead Dungeness crabs in many areas.

In 2006, by contrast, southerly winds appeared earlier than normal and brought nutrient-rich waters to shore all summer long, fueling algal blooms that again devastated the ecosystem.

In the past 2 years, the breeding seasons of many seabirds along the West Coast have been disrupted, says Julia Parrish, a marine biologist at the University of Washington in Seattle. In the Farallon Islands off California, auklets abandoned their nests and produced no chicks, presumably for lack of food. "These birds were stressed out when they should have been pigging out," she noted at the meeting.

Analyses of recent wind patterns suggest that year-to-year variability in the winds off Oregon is getting stronger, says Barth. The wind changes that the scientists have noted are consistent with what's expected in response to climate change, but the specific cause of the change in wind patterns is unknown, Lubchenco says. —S. PERKINS



MUSSELED OUT Poorly oxygenated waters off the coast of Oregon in the summers of 2005 and 2006 stifled the growth of sea life, such as the mussels and barnacles seen here.

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Professor John J. Renton says that predictions of the inevitable decrease and disappearance of worldwide oil supplies appear all too accurate. On the other hand, he notes, "Coal is to the United States what oil is to Saudi Arabia. We have more coal than anybody in the world." While other options certainly will be pursued, coal seems destined to play an increasingly important role in America's energy economy.

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STUDIES OF LIGHT AND SHADOW

Spotlighting dark matter and galaxy formation

BY RON COWEN

ew surveys of the sky are examining the two facets of galaxy formation. One focuses on the glitter. The other examines the gloom. A census of both the light and the dark parts of the cosmos is essential for understanding how today's universe came to be, the scientists say.

One of the new surveys looks at the panorama of galaxy shapes, masses, colors, and sizes that existed when the cosmos was about half its current age-a critical time when galaxies began to take the form they're in today. The other survey also sizes up galaxies but uses some gravitational sleight of hand to expose the dark side-the vast concentrations of dark matter that provide the framework for all the visible stars and gas in the universe. Dark matter, though unseen, makes

up more than 90 percent of the mass of the universe, theorists say.

Together, the new surveys paint a more detailed portrait of galaxies and their origin than astronomers have ever had.

DARK LANDSCAPE The Hubble Space Telescope's Cosmic Evolution Survey (COSMOS) is the largest galaxy study the telescope has ever conducted. It covers an area nine times the size of the full moon on the sky. That's big enough not only to map the distribution of several hundred thousand galaxies, but also to unveil the arrangement of dark matter in unprecedented detail.

"It's a milestone achievement to see where the dark matter lies," says COSMOS astronomer Richard Ellis of the California Institute of Technology (Caltech) in Pasadena.

Without this invisible stuff, he says, the universe as we know it wouldn't exist. According to the leading model for the formation of cosmic structure, dark matter coalesced earlier in the universe's history than ordinary, visible matter did. It's the tug of dark matter that pulled stars and gases into galaxies.

As the cosmos evolved, dark matter formed an irregular scaffold across the cosmos. Galaxies continue to concentrate in the densest regions of this network, forming the tapestry of galaxy clusters and superclusters seen today. Dark matter also maintains the shape of those clusters against the diluting effect of cosmic expansion, which would otherwise wash out cosmic structures.

Dark matter betrays its presence through its gravitational effect on visible matter. As first predicted by Albert Einstein in the 1930s, any large concentration of mass-visible or not-acts as a gravitational lens, bending the light coming to Earth from galaxies that lie directly behind that concentrated mass. The effect distorts the galaxies' observed shapes.

By measuring the shapes of half a million distant galaxies recorded with the sharp eye of Hubble's Advanced Camera for Surveys, Caltech astronomer Richard Massey and his collaborators inferred the distribution of matter that resides directly in front of those galaxies, as seen from Earth. The researchers describe their work in the Jan. 18 Nature. They also presented their findings in January at a meeting of the American Astronomical Society in Seattle.

Astronomers don't know the original, undistorted shape of any particular galaxy, notes Massey. But by analyzing the images of hundreds of thousands of galaxies, he and his colleagues found depar-

tures from the expected pattern of galactic shapes and, from those, estimated the distortions imprinted by dark matter.

NEW DIMENSION To add a critical third dimension to their work, the COSMOS researchers used the large Subaru telescope on Hawaii's Mauna Kea to record the colors of the galaxies observed by Hubble. The colors indicate approximate distance because the expansion of the universe shifts the light emitted by the most remote galaxies to the reddest wavelengths. The more distant the galaxy, the longer its light must travel to reach Earth, and the farther back in time observers see the galaxy.

Treating the survey as if it were an archaeological dig, the team divided the observable galaxies into slices

from three different cosmic epochs. Gravity-generated distortions in images of the galaxies from each time slice then enabled the researchers to map the distribution of dark matter as it appeared 3.5 billion, 5 billion, and 6.5 billion years ago. The earliest map represents the cosmos at nearly half its current age. The maps demonstrate how dark matter weaves a cosmic web, with filaments growing in size and density as the universe ages, Ellis says.

"It's very reassuring" that the dark matter structure revealed by COSMOS matches models that theorists have touted for more than 2 decades, notes Ellis. Mapping dark matter using the gravitational-lens technique dates back to the 1980s, but the distribution "has never been seen very clearly" or on such a large scale, he adds.

The Hubble study covers a smaller area of sky than searches for

6.5 billion

DARK CLUMPS — The Hubble Space Telescope's COSMOS survey revealed these images of dark matter as distributed (left to right) at 3.5 billion, 5 billion, and 6.5 billion years ago. As the dark matter coalesced into clumps, the densest areas formed the framework for clusters of galaxies.

dark matter with ground-based telescopes have, but the new observations drill deeper into space and include a higher density of galaxies, notes gravitational-lensing pioneer J. Anthony Tyson of the University of California, Davis.

"This is a great step forward, as observations from space avoid the distortion and time variation that Earth's atmosphere imposes

on the astronomical signal," notes theorist Eric Linder of the Lawrence Berkeley (Calif.) National Laboratory in a commentary accompanying the Jan. 18 *Nature* report on the COSMOS data. "The new maps have a much higher resolution than the best ground-based observations."

DARK AND LIGHT The COSMOS map has also enabled Ellis, Massey, and their colleagues to examine the evolution of galaxies. The researchers are seeing how well the galaxies "were painted on the dark matter," says Ellis.

In general, galaxies cluster around the densest concentrations of dark matter, in accord with theory, notes COSMOS Caltech astronomer Nick Scoville. Regions that shine brightly at X-ray wavelengths, an indicator of highly concentrated gas in a strong gravitational field, almost always overlap with the highest densities of dark matter. Nonetheless,

notes Scoville, there are some puzzling discrepancies. In some places, the galaxies clump where there is no underly-

ing dark matter, and some dark matter coalesces where no corresponding bright material lies. "For the dark matter skeleton of mass in the universe, flesh sometimes occurs without supporting bones, and bones without surrounding flesh," notes Linder.

It's too soon to tell whether the discrepancies merely point to the limited sensitivity of Hubble's detectors and the team's imageprocessing technique or whether they represent true anomalies, says Scoville. Differences would be expected if proposed dark matter particles were to interact with matter only though gravity. In contrast, visible matter can be pushed around by other forces, including the pressure of light. The clumping might also elucidate the nature of dark matter, since different types of dark matter particles would clump in different ways.

Obtaining more information on the clumping of dark matter would require a much broader study of the heavens. Tyson and his colleagues have proposed a survey across the entire sky using a ground-based telescope to be built atop Cerro Pachon in Chile.

The COSMOS survey provides new evidence that the young universe contained many more small, closely packed galaxies than it does today. That observation supports the "bottom-up" model of galaxy formation, which holds that many large galaxies such as the Milky Way are the products of the merger of dwarf galaxies.

COSMOS also corroborates previous findings that galaxies now forming large numbers of stars tend to be lower in mass and situated in lower-density regions of the dark matter framework than are galaxies that formed most of their stars in the past.

Theorists call this shift—from big to little—in star-formation activity downsizing. They argue that the massive galaxies associated with the densest concentration of dark matter formed and evolved faster than small galaxies in less-populated regions, where gravity takes longer to condense enough matter to ignite star formation. Scoville and his colleagues report their findings supporting the downsizing scenario in an upcoming *Astrophysical Journal*.

THE BRIGHT SIDE Another large survey, called AEGIS (for All-wavelength Extended Groth Strip International Survey), is also shedding light on galaxy formation. The study is an exten-

sion of one begun in 1994, when Princeton University astronomer Edward J. Groth used Hubble to record a small field of galaxies.

AEGIS has now directly measured the distances to more than 10,000 galaxies dating to when the universe was about half its current age. A team led by Sandy Faber of the University of California, Santa Cruz and Marc Davis of the Univer-

> sity of California, Davis measured those distances using a spectrograph on the Keck 2 telescope atop Mauna Kea. The device simultaneously takes the spectra of 150 galaxies.

> A host of other ground-based telescopes, as well as Hubble and the Chandra X-ray Observatory in space, have added to the survey. The array has registered emissions ranging from the shortest, most-energetic X rays to the longest radio waves coming from galaxies. AEGIS' observations trace the rate of star formation over the last half of cosmic history and gauge the mass of the galaxies in which stars reside.

> The survey finds that heavy galaxies formed their stars relatively early in cosmic history, while many less-massive galaxies are late bloomers that are still making stars steadily.

"To understand the properties of galaxies like our Milky Way, it is crucial to know when back in time they made how many of their stars," says AEGIS researcher Kai Noeske of the University of California, Santa Cruz.

QUIETLY MAKING STARS Collisions between galaxies fan the flame of star formation by stirring up gases and dust, which then condense into stars. Previous studies show that collisions played a key role in triggering sudden bursts of star birth during the early history of the universe.

But to the surprise of many astronomers, collisions don't appear to have played dominant roles in making stars during the past several billion years. The AEGIS team reports this finding in an upcoming *Astrophysical Journal Letters* devoted to the survey's results.

Rather than producing stars in bursts, galaxies within a few billion light-years of Earth steadily convert gas into stars until their gas supplies dwindle. Moreover, the rate of star formation in galaxies is tightly related to the total mass of stars they possess. The lowest-mass galaxies produce stars at a slow rate.

Faber, Davis, and their team came to those unexpected conclusions after using the Keck 2 spectrograph to measure the mass, star-formation rate, and number of stars already formed for some 3,500 galaxies. The study revealed that galaxies of similar weight tend to have about the same star-formation rate. That correlation is strongest for the lowest-mass galaxies.

"This is not what you would expect if strong starbursts were frequent—some galaxies would be star bursting, some would be quiescent, and star-formation rates would be all over the place," says Noeske. "We see that the average level of this range of star formation declines with time, in a gradual manner."

The survey indicates that "galaxies of a given mass march in a loose lockstep," says Noeske. "Star formation in galaxies follows a quite simple pattern," he asserts, "and simple patterns often mean that there are only few basic physical mechanisms at work. ...We can now find out what these mechanisms are by measuring how star formation behaves with time and mass of the galaxy, and compare that behavior to models."

Astronomers plan to combine data from surveys such as COS-MOS and AEGIS, piecing together the light and the dark views of the universe, to glean the full story of how galaxies evolved.



FRACTAL OR FAKE?

Novel art-authentication method is challenged

BY JULIE J. REHMEYER

ackson Pollock couldn't possibly have been thinking of fractals when he started flinging and dripping paint from a stick onto canvas. After all, mathematicians didn't develop the idea of a fractal until a couple of decades later. But if one physicist is right, Pollock ended up painting fractals anyway. And that mathematical quality may explain why Pollock's seemingly chaotic streams of paint come together

into an ordered, beautiful whole, and why the technique brought Pollock acclaim as a master of American abstract painting.

A fractal is a geometric structure in which the shapes at a large scale reflect the shapes at a small scale, forming an interlocking set of patterns that nest inside each other like Russian dolls. Approximations of fractal structures have been noticed throughout nature. For example, the overall crystal structure of a snowflake looks remarkably like the structure in a single arm. And the ridges of a mountain range jut into the sky, forming patterns

approach. "Either Taylor is wrong, or Kate's drawings are worth \$40 million," says Jones-Smith's collaborator Harsh Mathur. "We'd be happy either way."

The attack by Jones-Smith and Mathur has sparked debate within the field and prompted a defense by the father of fractals, Benoît Mandelbrot, a professor emeritus at Yale University. "I have extraordinary experience of these structures," Mandelbrot says. Drawing on that experience, "I do believe that Pollocks are fractal," he concludes.

GEOMETRICAL FRACTALS Although it wasn't until 1975 that Mandelbrot developed the notion of a fractal, mathematicians

contains it.

much like a snowflake.



PAINTING UNDER A MICROSCOPE Fractals are objects that look the same under magnification as they do as a whole. One researcher says that Jackson Pollock paintings have that property.

similar to the crags thrusting out from a single peak.

In the same way, the web of large streaks of paint across a whole Pollock painting resembles the finer network covering a small section, Richard Taylor of the University of Oregon in Corvallis reported 8 years ago. He recently used these observations to investigate whether newly discovered paintings are really by Pollock, and hence worth millions of dollars, or whether they're destined for a garage sale. He proposes that the fractal nature of the paintings illuminates what made Pollock a genius rather than a mere slinger of paint.

Sexy results indeed-to some researchers, too sexy. Two scientists at Case Western Reserve University in Cleveland say that Taylor is stretching the mathematics too far to get his results. No fractals are lurking within the Pollock paintings, they say.

When Katherine Jones-Smith made some doodles on a page-"pretty ugly" ones, she says—she found that they shared the qualities of a Pollock, according to an analysis that follows Taylor's

cotton market. He noticed a surprising regularity: A plot of the seemingly random price variations over the course of a month looked just like a plot of the variations over a decade.

Soon, he was seeing such a pattern in remarkably many seemingly unrelated situations. The graph of the rise and fall of the Nile over a week resembled the graph over a century. The bumps and dips of the coast of Britain roughly resembled the irregular edge of a single cove. He dubbed objects with this pattern of self-similarity at different scales "fractal," from the Latin word for "broken" or "irregular."

Years later, the combination of visual beauty and geometrical precision of many fractals attracted Taylor, who had long been torn between physics and art. Alongside his career in physics, he created abstract art, even leaving physics for a time to study painting at the Manchester School of Art in England.

During that period, Taylor studied Pollock's paintings. The chaotic streams of paint seem far from the orderly precision of a Koch curve, but whenever Taylor looked at a small section of a Pollock painting, it looked similar to the overall structure of the whole.

The paintings didn't show the perfect self-similarity of a geometrical fractal like the Koch curve, but natural objects never do. Nature tends to improvise, provide variations on a theme, rather than repeat patterns exactly. A mountain range doesn't have precisely the same shape as the crags on a single mountain, but the two are similar. Taylor saw the same kinds of similarities in the Pollock paintings.

Taylor thought that the observation might help explain particular qualities. "Pollock's paintings are frequently described as appearing 'organic' and 'natural," Taylor says. "Pollock himself said that 'My concerns are with the rhythms of nature' and that 'I am nature.'" Was it the fractal feature of Pollock's paintings that created that organic quality?

Taylor pursued his idea by computing a statistic called the "fractal dimension," which mathematicians had developed to understand some of fractals' odd qualities. Ordinary lines with no breadth are said to have one dimension, and flat planes have two. But the Koch curve was puzzling. Since it is built from lines, it seemed as if it should be one-dimensional. But with more and more iterations of the curve, the line appears fuzzy, as if it had breadth. It couldn't be two-dimensional, though, because it doesn't fully fill any area.

So, mathematicians proposed a new notion of dimensionality-one in which the Koch curve is dimension 1.26. A less complex fractal would have a dimension closer to 1, and a more complex fractal would have a dimension closer to 2.

Taylor took a digital image of a Pollock painting into his lab, broke the image into its separate colors, and computed the fractal dimension of the lines in each color. Each time, he got a number

between 1 and 2, confirming his notion that Pollock's paintings are fractal. "Rather than mimicking nature," Taylor says, Pollock "adopted its language— fractals—to build his own patterns."

In 1999, Taylor reported that the fractal dimension of Pollock's paintings increased during his life. His early drip paintings have a loose web of lines, mostly at the same scale. Because these paintings show no fractal qualities, their dimension is near 1. But Pollock's later paintings have a dense network of overlapping lines, ranging from large, bold strokes to delicate threads, Taylor calculated a fractal dimension of 1.72 for these works.

Taylor speculates that Pollock developed his artwork this way intentionally, "but on an intuitive, rather than an intellectual, level."

THE CHALLENGE In 2004, a graduate student in astrophysics at Case Western, Jones-Smith was to give a talk to her fellow students. "I was sort of bored with particle astrophysics," Jones-Smith says, so she looked around for something different. She came across an account of Taylor's work, and "it sounded really cool," she recalls.

"The obvious check to me was to make sure that not any old scribble would appear to be fractal," she says. "So, I made some scribbles." Much to her surprise, when she computed the fractal dimension of her scribbles, they turned out to be greater than 1.

Taylor's claim that the fractals in Pollock's paintings explained their aesthetic appeal doesn't hold up under mathematical scrutiny, Jones-Smith concluded. Mathur told her to publish her critique. But, since Taylor's research was 5 years old by that time, JonesSmith decided that no one would care about her analysis. She dropped it and continued with her astrophysics work.

Last February, however, she read a story about Taylor in the newspaper. Back in 2002, Alex Matter found among his deceased parents' belongings a cache of 32 works that were painted in Pollock's drip style. Matter's parents had been friends with Pollock. Matter also found a note in his father's handwriting that said that the paintings were a "gift + purchase." If the paintings were genuine Pollocks, the find would be like a winning lottery ticket. One of Pollock's paintings, "No. 5, 1948," sold recently for \$140 million.

> The Pollock-Krasner Foundation, which handles Pollock's estate, turned to experts to determine the authenticity of the paintings. Taylor was asked to use his fractal analysis to give objective, scientific input.

> When Taylor analyzed the new paintings, he found that none showed the fractal characteristics of many of Pollock's other paintings. Taylor will report his findings in an upcoming Pattern Recognition Letters. He cautions that his findings aren't definitive but should be considered with reports from other experts.

> When Jones-Smith read the newspaper story about the analysis, she was dumbfounded. "What good is it to use Taylor's criteria to authenticate Pollocks if they can be imitated with such ease?" she asks. So, she and Mathur decided to go public with her critique. It was published in the Nov. 30, 2006 Nature.

> Jones-Smith and Mathur argue that there's a fundamental problem with Taylor's work. Geometrical fractals show similar patterns at any degree of magnification: No matter how far you zoom in on the Koch curve, it looks the same. No natural object can match that. After all, the molecular structure of a pebble has no particular resemblance to the structure of an entire mountain range. But natural objects that are considered fractal do show

similar patterns across several orders of magnitude. There's been substantial debate about how many orders of magnitude are necessary for something to properly be considered fractal.

Pollock's paintings show fractal qualities over too small a range of orders of magnitude, Jones-Smith and Mathur say. "Everything looks fractal if you look over such a small range," Mathur says.

Taylor retorts that in his analysis, Jones-Smith's doodles don't have the same fractal characteristics that the Pollock paintings do. Furthermore, he says, the paintings show fractal patterns over a range of orders of magnitude consistent with other fractal research. Using the standards they advocate, "Jones-Smith and Mathur would also dismiss half the peer-reviewed published investigations of physical fractals," Taylor says.

"That is true," Jones-Smith says. "We would not be uncomfortable dismissing over half of the published accounts. We feel as though the term *fractal* is used overzealously."

THE COMMUNITY WEIGHS IN Jones-Smith has jumped into a decade-old argument. David Avnir of the Hebrew University of Jerusalem in 1998 criticized much fractal research on the grounds that most natural objects under study as fractals show fractal behavior over too small a range. He argues that Taylor shouldn't use the word *fractal* to describe Pollock paintings, so that word can be reserved for geometrical fractals and the few physical objects that show fractal behavior over a large range of scales.

But Lazaros Gallos, a fractals researcher at the City College of

A GEOMETRICAL SNOWFLAKE -The Koch curve was one of the first fractals discovered. To create one, start with a line segment, and then replace the middle third

with a triangle. Then

repeat, replacing the middle third of the resulting line segments with a tinier triangle. Keep going forever. Three Koch curves put together give a Koch snowflake.

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New York, says, "What [Jones-Smith and Mathur] have done is just a simple trick," Gallos says. "This is bad science about fractals." Gallos explains, "There's not a well-established definition of

fractals. When we try to give a definition, we mainly say that when you zoom in or out, it looks very similar to the whole." There's a strong indication that Pollock's paintings are fractal, he says, because they look fractal, and Jones-Smith's aren't because they don't.

Once the structure of an object has been determined to be fractal, the fractal dimension can be used to analyze that structure, Gallos says. But computing the fractal dimension of objects that aren't fractal is meaningless. "In practice," he says, "no matter what shape you take, you'll definitely get a non-integer fractal dimension."

Jones-Smith maintains that assessing whether or not a painting is fractal on the basis of appearance is subjective and unscientific. "I personally don't see small structure mirrored in large structure in Pollock's paintings," she says. "They look like a complete mess, as far as I'm concerned."

For authentication, it doesn't matter whether it's legitimate to call Pollock paintings fractal, says Michael Barnsley of Australian National University in Canberra. Taylor has a reproducible technique that produces numbers from a painting, and he can correlate those numbers with different artists. "That doesn't allow

you to authenticate or not authenticate a painting, but you could certainly add it into the collection of information that you have to say that it's more likely," he says. Jones-Smith argues that Taylor has studied only 17 paintings out of Pollock's 180 works, and that they are the most famous ones, not a representative sample. So, it's not clear, she says, whether the

patterns that Taylor has seen hold up across Pollock's work.

Taylor says that he hopes to analyze the remaining paintings and that he's also planning to apply different fractal techniques.

Jones-Smith and Mathur also intend to analyze some of Pollock's other paintings, looking for ones that don't fit with Taylor's analysis. Furthermore, Jones-Smith plans to make some drip paintings to see whether her inartistic renderings will have the characteristics that Taylor says are typical of Pollock's works.

So far, the Pollock-Krasner Foundation has made no official decision about the authenticity of the works. But on Jan. 29, a group at Harvard University released a study analyzing the pigments used in the paintings. Its results agreed with Taylor's suspicions about the paintings. The Harvard group found that the pigments weren't commercially available until years after Pollock's death in 1956.

Hany Farid, a computer scientist at Dartmouth University in Hanover, N.H., who has worked on art authentication, says that no matter how the quarrel over the fractal nature of Pollock's work turns out, Taylor's research points at something deeply true.

"The difference between math and art is not as great as people think," Farid says. "There is an art to mathematics and a mathematics to art." ■





FRACTAL FOOLERY — Katherine Jones-Smith made this doodle, "Pebbles," which she says shows the same fractal patterns that Taylor has found in Pollock paintings. Therefore, she argues, the paintings aren't fractal.

OF NOTE

PLANETARY SCIENCE Solar craft reaches a new low

The venerable Ulysses spacecraft has gone south.

That's just what solar scientists had been counting on. Earlier this month, the craft passed directly below the sun, looking at

the south pole from a distance of 329 million kilometers. In its 16 years of orbiting the sun, Ulysses has flown past the south pole only twice before, a feat no other solar probe has attempted.

Initially, Ulysses attained this rare perspective thanks to a gravitational assist from Jupiter that bent the craft's orbit out of the plane in which the planets orbit the sun. In its 6.3-year-long orbit, the craft passes from

the south pole to the equator and then over the north pole. The spacecraft has a good view of the sun's turbulent atmosphere and brewing solar storms.

As in 1994, the first time that Ulysses flew over the solar south pole, the sun is at the nadir of its 11-year activity cycle. However, the sun's magnetic field has reversed direction since the earlier passages, and the polar fields are now half the strength that they were in 1994, notes Ed Smith, Ulysses project scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif. Studying the poles under these changed conditions, he says, will enable Ulysses to provide information about how the sun's magnetic field controls the solar wind and shields Earth and other planets from cosmic rays coming from elsewhere in the Milky Way. -R.C.

SCIENCE & SOCIETY USDA proposes an office of science

The Department of Agriculture has proposed a plan to streamline its research activities. The Bush administration's proposed 2007 farm bill, unveiled by USDA Secretary Mike Johanns on Jan. 21, would merge two existing USDA research agencies into a single office of science.

Currently, the Agricultural Research Service (ARS) employs some 2,100 scientists and another 6,000 support staff at 107 laboratories around the country. Nearly 500 more people—mostly administrators make up the Cooperative State Research, Education, and Extension Service (CSREES), which funds research at universities and other nongovernmental facilities. The two agencies split a \$2.4 billion annual research budget.

"The goal of this merger [is to] get more coordination and collaboration" in federally funded agricultural research, says Lowell Randel, USDA's legislative-

> affairs director in Washington, D.C. "We currently have ... staff within ARS and CSREES that handle research in similar areas," such as livestock diseases, human nutrition, and plant breeding, he explains.

Randel denied that the move is intended to cut USDA research funding. "In fact, if you look at our farm bill proposal, we're actually looking to increase the investment in research."

For instance, Randel said, the bill would boost by \$100 million per year research into what USDA terms specialty crops, such as heirloom varieties of produce. Also, an extra \$50 million per year would develop new technologies for converting plants into renewable fuels. —J.R.

FOOD SCIENCE Want that fiber regular or decaf?

Researchers in Spain report that a cup of coffee can deliver a significant portion of daily dietary fiber. The drink hadn't been known to contain any fiber.

Like the cholesterol-lowering substances found in oat bran, fiber in coffee consists of carbohydrates that the body can't digest, but which dissolve in digestive fluids. However, unlike oat bran's soluble fiber, the fibrous constituents of coffee haven't been proven to benefit health, notes food scientist Fulgencio Saura-Calixto. His team at the Spanish National Research Council in Madrid recently developed a technique to isolate fiber from various drinks, including those assumed to have none.

Coffee's fiber molecules are small enough to easily pass through most coffee filters, Saura-Calixto and team member M. Elena Díaz-Rubio report in an upcoming *Journal of Agricultural and Food Chemistry*. Per unit volume, liquid coffee made using freeze-dried crystals contained 60 percent more fiber than conventionally filtered coffee did. Saura-Calixto says that he suspects that more fiber is extracted from coffee beans by the 200°C process used to make freeze-dried coffee crystals than by the cooler steps used in making ground coffee.

The recommended amount of dietary fiber the United States is about 28 grams per day, but most people don't come near that target. The new data indicate that 2 cups of instant coffee per day might contribute up to 3.6 g of fiber. —J.R.

Bacteria go for a spin

Researchers may have found the mechanism powering a mysterious gliding motion in bacteria.

Bacterial locomotion often relies on appendages. Filamentous structures called flagella propel some microbes, while others glide using pili, extensions that a microbe shoots out from its leading end and then retracts to pull itself forward.

But another form of gliding, first described nearly 3 decades ago, doesn't involve appendages. To search for the motor, David R. Zusman of the University of California, Berkeley and his colleagues fused a fluorescent protein to a microbial protein known to be necessary for this type of gliding in the rod-shaped bacterium *Myxococcus xanthus*.

The researchers found that the fluorescent spot remained stationary while the microbe cruised forward. They suspect that the labeled protein is part of an internal protein complex that enables it to push off from the surface. Meanwhile, another protein within this complex appears to track along a helical structure inside the microbe, propelling it forward in a corkscrew motion. The complex forms at the leading edge of the microbe and then disassembles as it moves past it, while a new complex forms farther ahead. The team describes the mechanism in the Feb. 9 *Science*.

Zusman's group is now investigating the internal helical structure and determining the proteins within the complex. "Once you know what makes cells move, then you can look for chemicals that can interfere with the movement," Zusman says. That might be helpful because a microbe's mobility plays a role in its virulence, he says. —A.C.



POLAR EXPLORER The Ulysses craft passes over the sun's south pole, in this artist's depiction, and broadcasts data to Earth.

ESA,

MEETINGS

PATHOLOGY Brains carry odd load after strokes

People who die from a stroke have accumulations of a protein called amyloid beta in the thalamus, a part of the brain involved in motor control, sensory processing, and signal relaying, researchers report.

In healthy people, the brain routinely makes and clears away amyloid beta, whose normal role is poorly understood. But in the brains of people with Alzheimer's disease, amyloid beta gathers into waxy clumps—a development widely believed to contribute to this form of dementia.

No clear connection between amyloid beta and stroke had ever been established in people, but animal tests suggested a link.

Biochemist Jukka Jolkkonen of the University of Kuopio in Finland and his colleagues examined stored brain tissues from 427 people who had died after a stroke had shut off blood to a portion of their brains and 57 people who had had no strokes. No patient in either group had been diagnosed with Alzheimer's disease or any other form of dementia. The stroke and nonstroke groups had the same average age at death.

The stroke victims had significantly greater amyloid beta accumulations in the thalamus than did the others, even though the thalamus itself hadn't suffered damage in the stroke patients, says Jolkkonen.

The thalamus is near the end of arterial branches, making the area slow to routinely clear amyloid beta, says Jolkkonen. While the location puts it away from areas of direct stroke damage, Jolkkonen hypothesizes that the stress of a stroke in another part of the brain disrupts signals between those areas and the thalamus, further hindering amyloid beta clearance there. -N.S.

HEREDITY

Aneurysm risk may get passed down

A heightened risk of having a brain aneurysm seems to be passed down in some families, and the life-threatening rupture of an aneurysm appears to strike earlier in a succeeding generation, a study finds.

An aneurysm is a ballooning of a blood vessel associated with weakening of the vessel's walls. While most brain aneurysms never rupture, those that do cause a bleeding stroke and are fatal up to 50 percent of the time.

International Stroke Conference San Francisco, Calif. February 7 - 9

Past research has shown that about 10 percent of people who develop a brain aneurysm have a relative who has one, a significantly higher proportion than among people in general, says Daniel Woo, a neurologist at the University of Cincinnati.

Woo and his colleagues contacted 35 families with a history of brain aneurysms. They found that children of a person with a brain aneurysm that ruptured faced twice the risk of having a brain aneurysm than children whose parents had aneurysms that never ruptured. The risk showed up even though the younger people smoked less and had lower blood pressure.

Moreover, aneurysm ruptures in the second generation occurred, on average, at age 41, whereas the ruptures struck parents when they were 56 years old on average.

The search for a genetic defect that could explain the increased risk is under way, Woo says.

Meanwhile, any of several brain-imaging techniques can detect brain aneurysms, Woo says. "In a family with a strong history of ruptured aneurysms, you might want to test the offspring at a young age," he adds. -N.S.

BIOMEDICINE Aspirin resistance carries real risks

The notion that some people are impervious to the blood-thinning effects of aspirin has been debated for more than 15 years. A meta-analysis of 17 studies now bolsters the evidence for "aspirin resistance" and indicates that the trait increases vulnerability to stroke and heart attack, heightens a person's risk of dying, and diminishes the effects of another commonly used blood thinner.

In the studies reviewed, out of 2,367 people with a history of heart problems or stroke, 618 had a blood-clotting ability that routinely overpowered aspirin's anticlotting effects.

About 33 percent of these aspirin-resistant people experienced a stroke, heart attack, or another vascular ailment during the course of the studies. In contrast, only 15 percent of the aspirin-sensitive people experienced any of these problems, says cardiac surgeon George Krasopoulos of the Royal Brompton Hospital in London.

Moreover, 5.7 percent of the aspirinresistant people died during the studies, compared with only 1.3 percent of those who were aspirin sensitive. Men were more likely to be resistant than women. People resistant to aspirin also seemed to get little benefit from the blood thinner clopidogrel (Plavix).

Krasopoulos, who was at Toronto General Hospital in Canada while conducting this analysis, says that previous research into aspirin resistance hadn't controlled well for variations in the frequency of aspirin use and dosage.

The biological mechanism underlying resistance is unclear. But the new analysis suggests that people susceptible to stroke or heart attack should be tested for aspirin resistance, since having it leaves them "at high risk of getting an adverse event," Krasopoulos says. —N.S.

NEUROLOGY Inside job dissolves blood clot pronto

An experimental procedure that delivers a clot-busting drug directly to the brain can bring on a remarkable turnaround in some stroke patients, researchers find.

"Some people improve even while they're on the [operating] table as we dissolve the clot," says radiologist Gregory Christoforidis of the Ohio State University College of Medicine in Columbus. For example, a patient might regain control over a side of his or her body that had been affected by the stroke and begin moving an arm or leg, he says.

In the procedure, a catheter tipped with a dose of the drug tissue plasminogen activator is threaded through arteries from the groin up to the site of the clot. There, the catheter releases the drug onto the blockage, a more direct approach than giving a patient intravenous drugs that flow throughout the body, says Christoforidis. The targeted approach also limits the risk of hemorrhage elsewhere in the body, he says.

Of 102 stroke patients given the intraarterial clot buster, 25 showed dramatic improvement over the course of 24 hours. All had had stroke symptoms for up to 6 hours at the times of their procedures. Standard clot busters are usually effective only up to 3 hours after symptoms start (*SN*: 1/18/03, p. 37).

The dramatic turnaround was more likely in patients who received the treatment within 3 hours and who had an array of alternative blood vessels that could supply brain tissue downstream from the clot.

Although the study measured the effects of the intraartery procedure done within 6 hours of stroke onset, other researchers are trying the approach on patients who have had symptoms for 12 to 24 hours. -N.S.

Books

A selection of new and notable books of scientific interest

GONE TOMORROW: The Hidden Life of Garbage HEATHER ROGERS

The United States is the world's number-one producer of garbage. Rogers, a journalist and filmmaker, explores where all this refuse goes and reveals



garbage's political, environmental, and social impacts. Strict environmental standards for landfills were implemented only in the past decade, she writes. Meanwhile, older sites have been leaching poisonous materials and gases into the water supply and the air. The book describes how today's landfills

are constructed to keep fluids from reaching groundwater. These crypts are eventually filled and then capped, supposedly concealing and preserving the refuse in perpetuity. Rogers chronicles the history of garbage's production, explaining how early 19th-century farmers recycled much of the waste that they produced, how urban-sanitation efforts were spurred by outbreaks of yellow fever and cholera, and how ever-growing cities have tackled the problem of refuse. She chronicles the environmental backlash that led to new laws, "green" capitalism, and recycling programs. *The New Press*, 2005, 288 p., b&w images, paperback, \$15.95.

UNCERTAINTY: Einstein, Heisenberg, Bohr, and the Struggle for the Soul of Science DAVID LINDLEY

With his now-famous uncertainty principle, a young German physicist named Werner Heisenberg shook the foundations of a discipline that prided itself on the precise establishment of facts and laws about



nature. Lindley, a former associate editor at *Science News*, reveals the history behind this groundbreaking pronouncement: that it is impossible to know exactly both the position and momentum of a particle, and that the very act of observing changes what is observed. This was an assertion, the author explains,

that Albert Einstein himself could not accept. For Einstein, classical physics, as well his as own theory of relativity, furnished complete laws under which the universe operated and left nothing to chance. Lindley traces the discoveries leading to Heisenberg's principle, including acceptance of the existence of atoms and the description of their structure by physicist Niels Bohr, who went on to become Heisenberg's mentor. It was in this role that Bohr sought to reconcile his pupil's new vision of guantum physics with the classical ideas to which Einstein adhered. Eventually, determinism of the sort upheld by Einstein gave way to a new worldview, based on probability in physics, that has been readily embraced outside of physics. Lindley notes how nonscientists, from philosophers to journalists to

anthropologists, have adopted Heisenberg's uncertainty principle to describe how the mere act of observing from some subjective point of view can affect what is being observed. *Doubleday, 2007, 257 p., hardcover, \$26.00.*

SMITHSONIAN INTIMATE GUIDE TO THE COSMOS

From a leading NASA illustrator comes this expressive and vividly illustrated guide to the cosmos. As Berry points out, astronomy is the oldest science known to man. While ancient humans relied on the movements of the sun and planets to determine the



passage of time, modern astronomy has advanced to portray in increasing detail the birth of the universe and the origin of life itself. Berry combines images from various space missions, including those of the Hubble Space Telescope and the Mars rovers, with

artists' renditions to take readers on an illustrated tour through the solar system and beyond. He provides up-to-date information about Earth and its neighbors, details scientists' search for planets outside our solar system, ponders the existence of life elsewhere in the universe, and speculates about life's origins here on Earth. For example, he describes how the search for Martians is a search not for little green men but for microorganisms that may survive in a variety of planetary conditions. Black holes, star-forming nebulae, dark energy, and the possibility of parallel universes are just a few of the other subjects that Berry tackles in this guide. *Smithsonian, 2007, 176 p., color images, paperback, \$15.95.*

THE FUTURE OF EVERYTHING: The Science of Prediction

Scientists have long sought to construct models that can make predictions pertaining to phenomena as diverse as the trajectory of moving objects, the economy, and even the intellect. While physics provides accurate predictions for the behavior of inanimate



objects, such as light waves and planetary motion, it does so on a basic level, eschewing many details. Orrell opens the book with the history of prediction. From the Oracle at Delphi to astrologers, people have sought to know the future. Similarly, scientists have sought to apply rules to nature and thus gain the ability

to predict the behavior of objects. However, with the discovery of chaos and the so-called butterfly effect came the realization that certain systems defied simple mathematical modeling. Orrell demonstrates the errors that arise in attempts to make precise weather forecasts, explains why it is impossible to predict the appearance or health of a living being based solely on genetic information, and explores the large psychological component involved in predicting economic phenomena. Finally, Orrell looks at what prediction means for determining the fate of our planet, including the ability to model global warming and predict earthquakes, catastrophic storms, and disease outbreaks. He ends the book with a list of probable scenarios for the year 2100 and a list of famous predictions. Avalon, 2007, 449 p., hardcover, \$27.95.

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LETTERS

No piece of cake

The new mathematical method for equitable cake sharing ("A Fair Slice: New method makes for equitable eating," SN: 12/16/06, p. 390) actually leads to a version of Zeno's paradox. The problem is that the cake remnant left after the referee gives the two eaters their respective. equally valued pieces is no more likely than is the cake as a whole to be homogeneously desirable, thus creating the same problem in equitably dividing it as was faced in dividing the whole cake-and so on for all the successive remnants. The problem of infinite regress can be solved, however, by a simple revision to the procedure: After the initial, equitable cut, the referee eats the remaining portion. NAOMI SCHEMAN, MINNEAPOLIS, MINN.

Peer shortcomings

The paucity of comments received by *Nature* in its Web experiment confirms the obvious: Few scientists can afford the time for peer reviews ("Peer Review under the Microscope," SN: 12/16/06, p. 392). Journal editors get paid for their work, so why not compensate outside reviewers? Furthermore, as professional rivalry is a genuine concern, why not eliminate the potential for bias by shielding the names of the authors until publication? Taking these two measures could expand the pool of peer reviewers, catch more faulty research andjust as important—improve the odds of publication for controversial-yet-valid research.

CHRISTOPHER ESSE, BEVERLY HILLS, CALIF.

I enjoyed learning about the journal *Nature's* experiment. Some federal agencies are implementing new procedures for peer reviewing scientific information used in making policy or disseminated to the public. Those "OMB Bulletin" procedures require a high degree of transparency similar that used in *Nature's* experiment. While costly and controversial, the procedures have the potential to improve the quality of scientific information on which our government bases its most important decisions. **NATALIE A. ROBERTS,** FAIRFAX, VA.

Sniffle piffle?

Is the causal relationship between mood and immune system response so obvious ("Sniffle-Busting Personalities: Positive mood guards against getting colds," *SN*: *12/16/06, p. 387*)? Could not a healthier immune system cause a more positive outlook, rather than the other way around? **LESTER WELCH**, AIKEN, S.C.

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