CarnegieScience

The Newsletter of the Carnegie Institution

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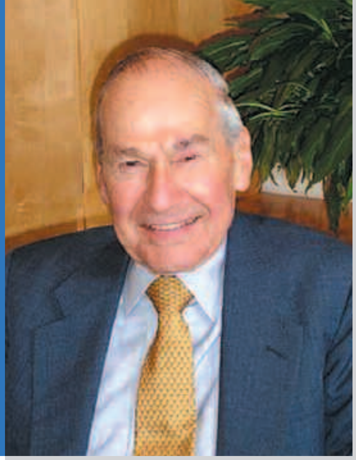
EMBRYOLOGY ◻ GEOPHYSICAL LABORATORY ◻ GLOBAL ECOLOGY ◻ THE OBSERVATORIES ◻
PLANT BIOLOGY ◻ TERRESTRIAL MAGNETISM ◻ CASE: CARNEGIE ACADEMY FOR SCIENCE EDUCATION

On the Inside



Carnegie's small size belies its long reach.

Fewer than 80 senior scientists populate our six departments. But in the last year alone these individuals, with their colleagues, have published over 550 scientific papers. The discoveries run the gamut from molecular biology to the large-scale structure of the universe. These impressive accomplishments could not happen without partnerships with outside organizations and scientists, liaisons with government agencies, relationships with our postdocs, and much more. It is through these connections that Carnegie enhances its impact.

Perhaps the most immediate example of a project with a very long reach is the recent successful flyby of the MESSENGER mission to Mercury. Sean Solomon, Director of Terrestrial Magnetism, is the principal investigator of that mission. Over the time it took to develop the scientific program, build and launch the craft, and analyze the recent data, he has worked with hundreds of different organizations, engineers, and scientists, and of course communicated with the public at large.

The Geophysical Laboratory's (GL) Carnegie/Department of Energy Alliance Center (CDAC), led by GL's new Director Rus Hemley and Ho-kwang (Dave) Mao, is another far-reaching endeavor. It is advancing high-pressure/high-temperature research to understand new materials, nuclear stockpiles, and planetary interiors. This project partners with 11 academic institutions and collaborates with groups in the U.S. and abroad. CDAC scientists also use facilities at the national laboratories, including the GL-managed HPCAT at the Advanced Photon Source. Carnegie investigators are the *de facto* leaders in this field; their innovative methods have become the standard for high-pressure research worldwide.

The Carnegie Observatories have been molding astronomy and telescope technology for over a century. The latest additions, the twin Magellan 6.5-meter telescopes built with our partners at Carnegie's Las Campanas Observatory, are widely considered to be among the best of the current generation of optical telescopes. And plans for the 24.5-meter Giant Magellan Telescope, to be built with a cluster of institutions, will take astronomy (and Carnegie) to an even higher level. It will redefine our knowledge about the origin of planetary systems; the formation of stars, galaxies and black holes; and the nature of dark matter and dark energy.

One of the most-used databases in all of biology is run by Sue Rhee at Plant Biology. The *Arabidopsis* Information Resource (TAIR) focuses on the experimental plant *Arabidopsis*. It helps researchers understand the genes involved in plant growth, development, and disease—critical information to feed a growing population and cope with consequences of climate change. That database has grown from 100,000 page hits per month in 2000 to well over 1 million in 2007 from researchers from over 120 countries.

The smallest and newest Carnegie department, Global Ecology, has been remarkably productive. Its researchers are sought by international organizations and federal and state governments for their expertise. Staff members serve on the Nobel-Prize-winning Intergovernmental Panel on Climate Change (IPCC), and they have worked tirelessly to bring an understanding of climate change to the public.

Carnegie postdoctoral fellows may have the longest reach. Their fresh ideas invigorate every department and, when their term with Carnegie is done, they spread Carnegie-style science to other institutions. As only one example, former postdoctoral associate Ben Ohlstein worked closely with Embryology Director Allan Spradling to reveal how stem cells know what to become. He now is on the faculty at Columbia University, influencing a whole new generation of scientists.

The longer I serve as Carnegie chairman, the more impressed I am with how this small organization continues to have a huge impact across many scientific disciplines. Andrew Carnegie believed that his formula of nurturing exceptional people would produce exceptional results that would benefit humankind. Time and time again, he's been proven right.

Michael E. Gellert, *Chairman*

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Terrestrial Magnetism Hosts Trustees

The Finance committee kicked off the 127th gathering of Carnegie's board of trustees December 6 at the institution's administration building in Washington, D.C.

The Research and Development committees and first session of the board also conducted business that day, followed by lab tours at the Department of Terrestrial Magnetism (DTM). There was also a DTM staff lecture and dinner in the newly refurbished Experiment Building, renamed the David Greenewalt Building, on the Broad Branch Road campus. The Nominating and Audit committees and the second session of the board completed their business on December 7.

After the board met on December 6, the trustees were bussed to the Broad Branch Road campus, where they were welcomed by DTM director Sean Solomon in the Greenewalt Building's new auditorium. Solomon introduced the interdisciplinary topics that staff scientists would explain on the tours: how the science of astrobiology is looking at the pathways that carbon takes from the interstellar medium to planets and eventually to form life; how Earth's continents evolved at the surface, in the middle and lower crust, and in the deep mantle; and how DTM researchers monitor tectonic fault zones and volcanoes.

After the tours and cocktails, the newest DTM staff member, Scott Sheppard, gave his talk, "The Third Domain of the Solar System." He discussed Trojan asteroids around Neptune—objects locked into roughly the same orbit as Neptune's—and so-called Kuiper Belt objects (KBOs), which reside beyond that planet's orbit. These small, lesser-known bodies can tell scientists much about how the Solar System and planets formed by their composition and the inclination of their orbits relative to the plane of the ecliptic (that is, the plane that contains the Sun, Earth, and the other major planets). After the lecture, staff and trustees dined in the Merle Tuve Room. □

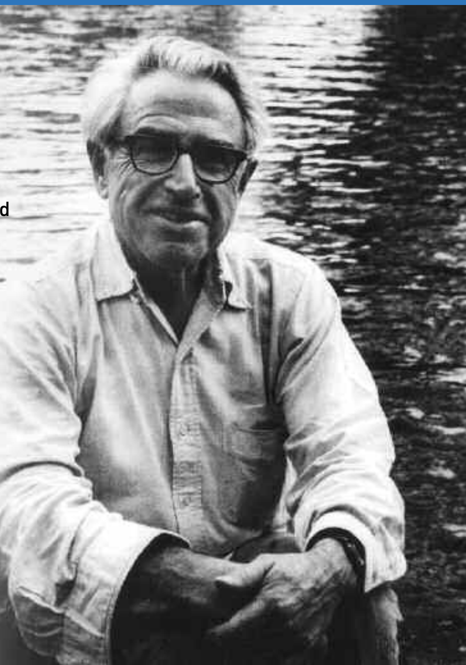
Director of the Observatories Wendy Freedman (top left) chats with trustee Michael Brin prior to a talk and demonstration by John Debes and Alycia Weinberger about organic matter in dense, gaseous disks surrounding young stars.

Trustee Mary-Claire King (below left) examines parts of a strainmeter. Strainmeters monitor tiny movements or strains within the Earth. Senior instrument maker and shop manager Nelson McWhorter (right) assembles and deploys these devices worldwide.

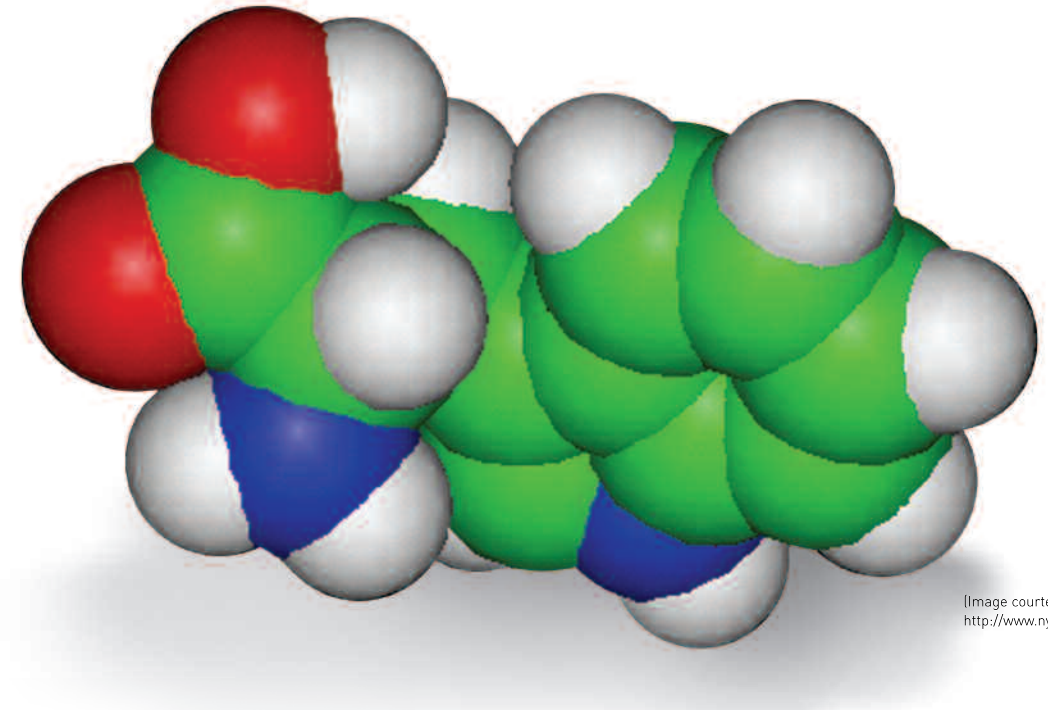
Senior Trustee William T. Golden Dies at 97

Senior trustee William T. Golden died on Sunday, October 7, at the age of 97. Bill Golden was an icon of American science policy, and the Carnegie Institution was privileged to have his support and guidance for more than 35 years. Dedicated, passionate, and always involved, Bill served as secretary of the Carnegie board of trustees from 1971 to 1999 and chaired or participated in numerous committees. He was particularly instrumental in the planning and construction of the Las Campanas Observatory in the Chilean Andes, now home to some of the largest and most scientifically productive telescopes in the Southern Hemisphere. The Carnegie Observatories auditorium in Pasadena, Calif., bears his name in appreciation of his efforts. Golden embodied the Carnegie principle that exceptional people can produce extraordinary results when given the freedom to pursue their passions.

Carnegie, the American Association for the Advancement of Science, and the National Academy of Sciences honored Golden's many contributions to science at a symposium concerning science advising, an area in which Golden had a profound impact. It was held at the administration building January 25, 2008. □



William T. Golden served Carnegie for 35 years.



Tryptophan (left) is an essential amino acid that all cells need to stay healthy. Carnegie researchers found that cancer disrupts tryptophan's normal metabolic cycle in immune cells, letting the disease take hold.

(Image courtesy NYU Library of 3-D Molecular Structures http://www.nyu.edu/pages/mathmol/library/life/life1.html)

How Cancer Takes Its Insidious Hold

T cells, those first responders in the war on disease, are also the first victims of a cancer invasion. A team led by researchers at the Department of Plant Biology found a key biochemical cycle that suppresses immune response and allows cancer cells to multiply unabated. The same cycle could also be involved in autoimmune diseases such as multiple sclerosis. The work was published in the September 25, 2007, issue of *PLoS Biology*.

The scientists used special molecular "nanosensors" called fluorescence resonance energy transfer, or FRET, to monitor levels of tryptophan, one of the essential amino acids that human cells need to live. As lead author and former Carnegie fellow Thijs Kaper explained, "Humans get tryptophan from foods such as grains, legumes, fruits, and meat. It's essential for normal growth and development in children and nitrogen balance in adults. T cells also depend on it for their immune response after invading cells have been recognized. If they don't get enough tryptophan, the T cells die and the invaders remain undetected."

The scientists looked at the chemical transformations that tryptophan undergoes as it is processed in live human cancer cells. When tryptophan is broken down in the cancer cells, an enzyme dubbed IDO forms molecules called kynurenines, normal products of tryptophan metabolism. Kynurenine reduces the concentration of tryptophan, thereby starving the T cells of the needed amino acid. A key finding is that a protein (LAT1) present in certain types of cancer cells exchanges tryptophan from outside the cell with kynurenine inside the cell, resulting in an excess of kynurenine.

"It's double trouble for T cells," remarked acting director of Plant Biology Wolf Frommer. "Not only do they starve from lack of tryptophan in their surroundings, but it is replaced by the toxic kynurenines, which wipe out other T cells."

The scientists think that this cycle may also be involved in cells implicated in certain autoimmune diseases. In these cases the cells may not be able to take up or convert enough tryptophan. Without enough of the amino acid or the IDO enzyme to convert tryptophan, the cells cannot produce enough kynurenine. Lacking kynurenine, the body's own T cells cannot be kept in check, so they rebel and attack the body.

The FRET system allows the scientists to visually track the location and concentration of biochemicals. The novel tryptophan nanosensor can be used to identify new drugs that could reduce the ability of cancer cells to uptake tryptophan or their ability to degrade it—potentially a huge boost to cancer treatment. □

It's Official: Site Selected for Giant Magellan Telescope

The Giant Magellan Telescope (GMT) Consortium announced in October that Carnegie's Cerro Las Campanas, Chile, site will be home to the GMT. The location, where the twin 6.5-meter Magellans and other telescopes reside, was selected for its high altitude, dry climate, dark skies, unsurpassed seeing quality, and access to the southern skies.

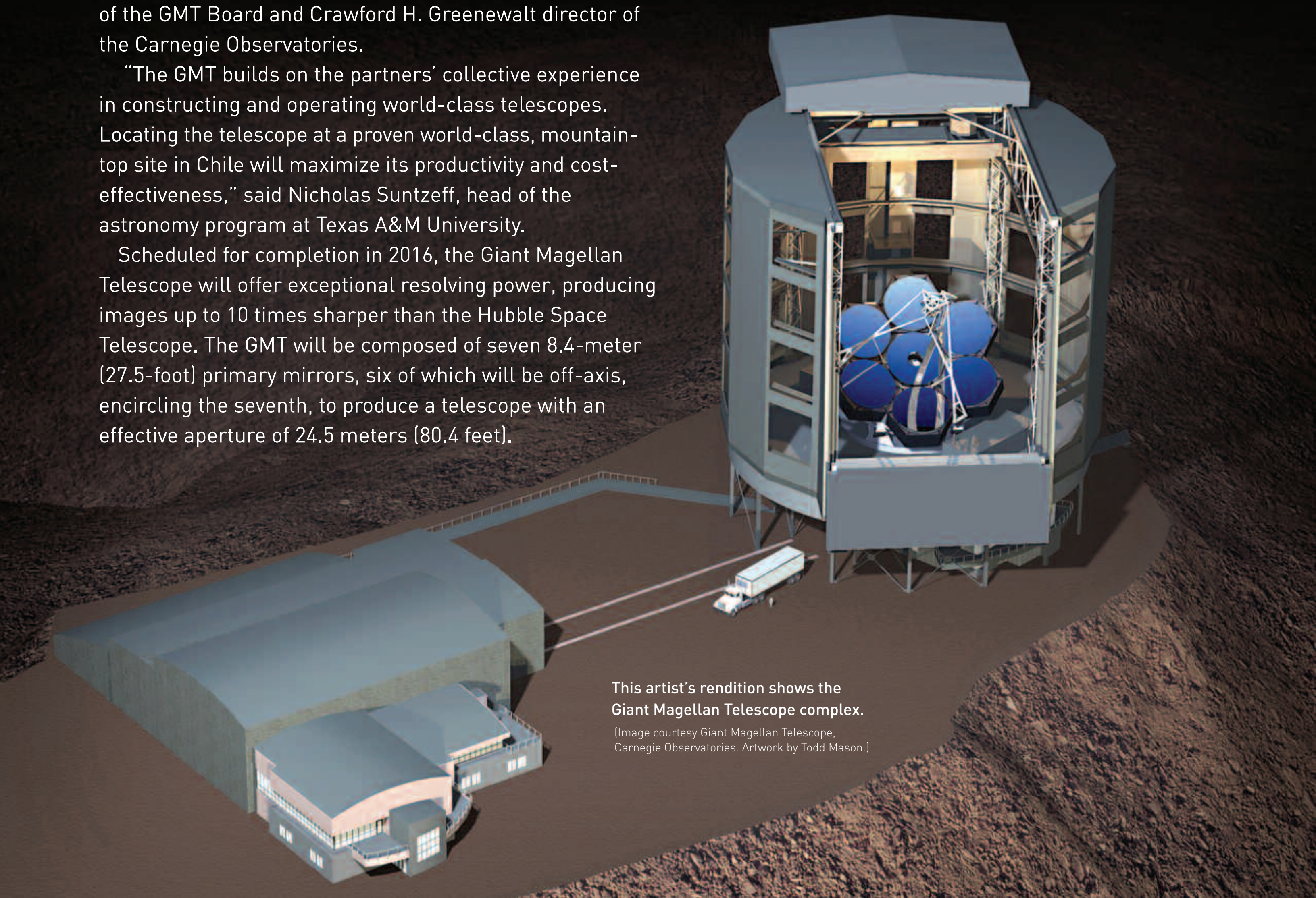
"This decision represents a critical step towards realizing our goal of building the premier next-generation astronomical observatory," said Wendy Freedman, leader of the GMT Board and Crawford H. Greenewalt director of the Carnegie Observatories.

"The GMT builds on the partners' collective experience in constructing and operating world-class telescopes. Locating the telescope at a proven world-class, mountain-top site in Chile will maximize its productivity and cost-effectiveness," said Nicholas Suntzeff, head of the astronomy program at Texas A&M University.

Scheduled for completion in 2016, the Giant Magellan Telescope will offer exceptional resolving power, producing images up to 10 times sharper than the Hubble Space Telescope. The GMT will be composed of seven 8.4-meter (27.5-foot) primary mirrors, six of which will be off-axis, encircling the seventh, to produce a telescope with an effective aperture of 24.5 meters (80.4 feet).

The first GMT mirror was cast from molten glass in July 2005 and is currently being polished at the University of Arizona's Steward Observatory Mirror Laboratory. When completed in early 2009, the final surface will be smooth to an accuracy of 1 millionth of an inch and will follow the precise optical prescription needed to produce the best images theoretically possible.

Detailed information about the design of the GMT and the science that it will perform is located at http://www.gmto.org/. □



This artist's rendition shows the Giant Magellan Telescope complex.

(Image courtesy Giant Magellan Telescope, Carnegie Observatories. Artwork by Todd Mason.)

Small Department

Huge Impact

Want to know what Global Ecology scientists have been up to? Just check out the *New York Times, USA Today,* National Public Radio, or other media outlets worldwide. From coral reefs to Hawaiian rain forests to the Nobel ceremonies in Oslo, Carnegie researchers are making headlines as they address some of the most critical issues facing the world today. Some examples:

This image is an aerial view of isolated native ohia trees awash in a sea of invasive strawberry guava trees in Hawaii. The dense canopy formed by the strawberry guavas blocks light and suppresses growth of native plants.

(Image reprinted with permission from the *Proceedings of the National Academy of Sciences*, early, on-line edition, March 3-7, article 07-10811, Copyright 2008.)

Why is the CO_2 Rise Accelerating?

Global Ecology director Chris Field and colleagues report in the October 2007 *Proceedings of the National Academy of Sciences* that human activities are releasing carbon dioxide faster than ever, while the natural processes that normally slow its buildup in the atmosphere appear to be weakening.

Between 2000 and 2006, activities such as burning fossil fuels, manufacturing cement, and destroying tropical forests contributed an average of 4.1 billion metric tons of carbon to the atmosphere annually, yielding an annual growth rate for atmospheric carbon dioxide of 1.93 parts per million (ppm). "This is the highest since the beginning of continuous monitoring in 1959," states the report. The present concentration is 381 ppm, the highest in the last 650,000 years—and probably in the last 20 million years.

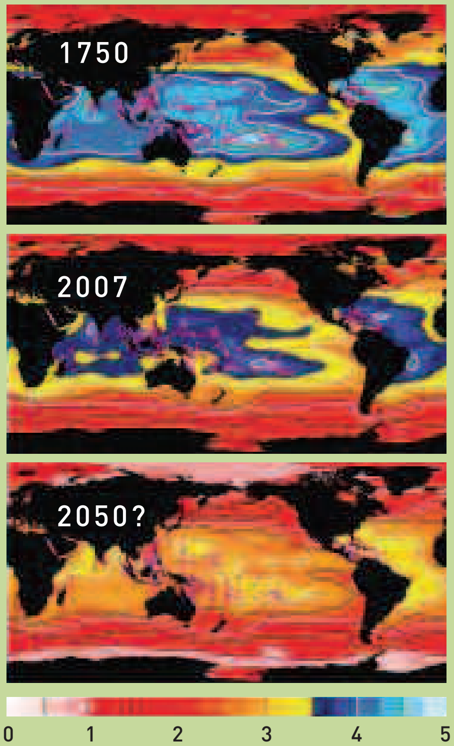
The worldwide acceleration in emissions had been noted before, but the *PNAS* report gives insight into its causes. "The new twist here is the demonstration that weakening land and ocean sinks are contributing to the accelerating growth of atmospheric CO_2," says Field.

Changing wind patterns over the Southern Ocean have brought carbon-rich water toward the surface, reducing the ocean's ability to absorb carbon dioxide. On land, where plants are the primary carbon sinks, large droughts have reduced uptake.

But fossil-fuel emissions are soaring. An average of 7.6 billion metric tons were released each year between 2000 and 2006, a significant jump from 6.5 billion tons per year in the 1990s.

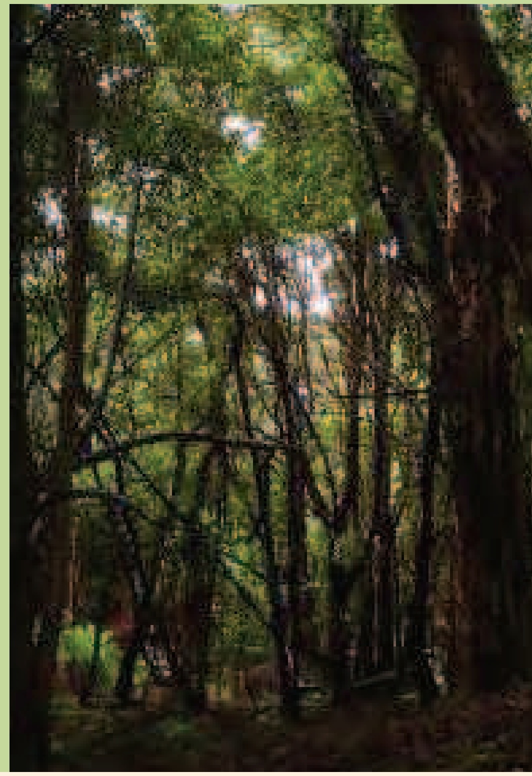
The study also found that the carbon intensity of the global economy (kilograms of carbon per dollar of activity) has increased since 2000, reversing a 30-year decline. This increase presents a particular challenge for stabilizing atmospheric carbon dioxide and mitigating climate change.

ARAGONITE SATURATION



In year 1750, over 98% of coral reefs (magenta dots) grew in optimal conditions with aragonite saturation, needed for skeletal growth, greater than 3.5 (blue colors). Such water is rapidly disappearing and will be gone in several decades if current carbon dioxide emission trends continue. Atmospheric CO_2 levels are 280 ppm, 380 ppm, and 550 ppm for years 1750, 2007, and 2050, respectively.

The highly invasive Canary Island fire tree forms a denser canopy than native ohia trees, leaving the Hawaiian forest floor in the dark.



Acid Testing Coral Reefs

Carbon emissions are not just heating up the globe; they are also changing the oceans' chemistry. This situation could soon be fatal to coral reefs, which serve as havens for marine biodiversity and underpin the economies of many coastal communities. Ken Caldeira and Long Cao have calculated that if current carbon dioxide emission trends continue, by mid-century 98% of present-day reef habitats will be too acidic for reef growth. Among the first victims will be Australia's Great Barrier Reef, the world's largest organic structure.

Caldeira and Cao presented their results in a multiauthor paper in the December 14, 2007, issue of *Science* and at the 2007 annual meeting of the American Geophysical Union. The work is based on computer simulations of ocean chemistry under levels of atmospheric CO_2 ranging from pre-industrial levels to high future concentrations.

"About a third of the carbon dioxide put into the atmosphere is absorbed by the oceans," says Caldeira, "which helps slow greenhouse warming but is a major pollutant of the oceans." The absorbed CO_2 produces carbonic acid, the same acid that gives soft drinks their fizz, which threatens aragonite, the mineral used by corals and many other marine organisms for their skeletons.

Before the industrial revolution, over 98% of warm-water coral reefs were in waters from which corals could easily produce aragonite to build reefs. "But if atmospheric CO_2 stabilizes at 550 ppm—and even that would take concerted international effort to achieve—no existing coral reef will remain in such an environment," says Cao.

"These changes come at a time when reefs are already stressed by climate change, overfishing, and other types of pollution," says Caldeira, "so unless we take action soon, there is a very real possibility that coral reefs—and everything that depends on them—will not survive this century."

Combating Invading Trees in Rain Forests

You can add one more to the list of threats to tropical rain forests—tree invasions. Greg Asner and colleagues warn that non-native trees invading a rain forest can change its basic ecological structure—rendering it less hospitable to myriad native species. The results are published in the *Proceedings of the National Academy of Sciences.*

The research team used the remote sensing technology of the Carnegie Airborne Observatory (CAO) to survey the impact of invasives on more than 850 square miles of rain forest on the island of Hawaii.

"Invasive tree species often show biochemical, physiological, and structural properties that are different from native species," says Asner. "We can use these 'fingerprints' combined with the 3-D images to see how the invasives are changing the forest."

This was the first time the approach has been used to track invasives in Hawaii, where roughly half of all organisms are non-native and approximately 120 plant species are considered highly invasive. In rain forests, the slow-growing native ohia tree is losing ground to newcomers.

CAO surveys found that stands of two invasive tree species form denser canopies than do the native ohia trees. Less light reaches lower levels, suppressing native understory plants.

Introduced trees can also pave the way for more invaders by altering soil fertility. The invading Moluccan albizia concentrates atmospheric nitrogen in the soil, speeding the growth of the strawberry guava. The invasive guava trees form a dense, mid-level thicket that blocks light and stifles young native plants.

"These species can spread across protected areas without the help of land use changes or other human activities," says Asner. "This suggests that traditional conservation approaches on the ground aren't enough for the long-term survival of Hawaii's rain forests." Asner and colleagues plan to expand their CAO surveys to other forests. □

Finding Something You're Not Looking For

Looking for something else altogether, Michael Rauch and George Becker of the Observatories, and their colleagues, found a new population of faint protogalaxies from a time when the universe was only 15% of its present age. They conducted the most sensitive spectroscopic survey ever of objects from that time. The ancient objects are the likely precursors of galaxies today.

"We were actually trying to measure a faint signal from intergalactic gas caused by the cosmic ultraviolet background radiation," explained Rauch. "But as often happens in science, we got a surprise and found something we weren't looking for—dozens of faint, discrete objects emitting radiation from neutral hydrogen in the so-called Lyman-alpha line, a fundamental signature of protogalaxies."

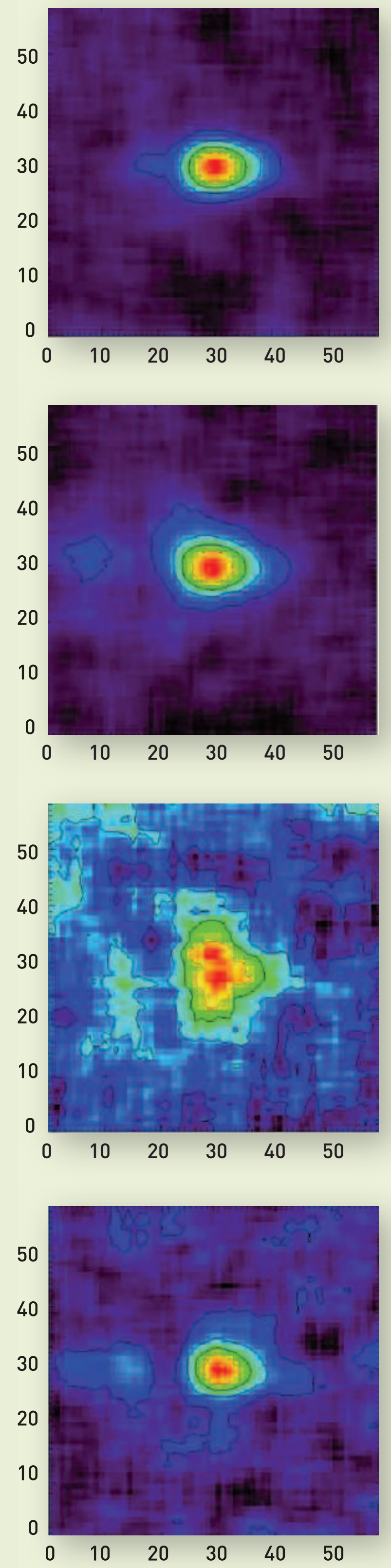
The team used the European Southern Observatory's Very Large Telescope for an unprecedented 92 hours to obtain a spectrum of the universe when it was only 2 billion years old. Most astronomers believe that when the universe was young it was filled with a thin, almost uniform gas. A popular theory of galaxy formation predicts that the gas accreted, hierarchically forming smaller protogalaxies, which then collided and merged to become the massive galaxies seen today. The new discovery lends strong support to this theory.

During the 1990s there was mounting evidence in favor of this hierarchical picture of galactic evolution, including measurements of distant quasars by Rauch and collaborators. Their work showed how the properties of cosmic gas clouds—the reservoir of matter for galaxy formation—fit within that scheme.

"Most of those gas clouds are dark and visible only as foreground objects, which cast something of a shadow against a bright background quasar," Becker said. "Intriguingly, one class of these shadows—known as damped Lyman-alpha systems—was suspected to arise when those small protogalactic building blocks intersect the line of sight to the quasar. For many years, these shadows were our only hint that a population of numerous early galaxies existed."

Until now this possibility could not be tested because these protogalaxies, with their low masses and tiny stellar populations, were too faint for observations. The weak light signal that the team has now detected from these objects implies low star-formation rates and a still-small amount of chemical enrichment, as expected for young galaxies. The objects are about 20 times more common than all the distant galaxies ever previously seen from ground-based surveys, a finding consistent with the properties of the puzzling damped Lyman-alpha shadows and with the abundance of early low-mass protogalaxies in the hierarchical picture. □

The research was published in the *Astrophysical Journal.*



Hydrogen atoms in distant galaxies and in the intergalactic medium absorb or release photons of light at specific wavelengths, producing characteristic absorption or emission lines when the light is dispersed into a spectrum. These are spectra of likely protogalaxies seen when the universe was at 15% of its present age. They show the Lyman-alpha emission line region characteristic of a population of low-mass, weakly star-forming galaxies commonly believed to be the building blocks of bright present-day galaxies. Michael Rauch, George Becker, and colleagues found these objects, which are about ten times fainter than any galaxies ever seen in ground-based observations.

THE AUTHORS ON THIS STUDY ARE MICHAEL RAUCH, MARTIN HAEHNELT, ANDREW BUNKER, GEORGE BECKER, FRANCINE MARLEAU, JAMES GRAHAM, STEFANO CRISTIANI, MATT JARVIS, CEDRIC LACEY, SIMON MORRIS, CÉLINE PÉROUX, HUUB ROETTGERING, AND TOM THEUNS.

Deep Down Spin City

By mimicking conditions in the lower mantle and probing certain properties of iron, Geophysical Laboratory scientists have shown that material in Earth's lower mantle does not behave as predicted. A newly defined zone may be at work.

Surface phenomena such as volcanoes and earthquakes are generated by what goes on in Earth's interior. The lower mantle is between 400 and 1,740 miles (650 and 2,800 km) deep and sits atop the outer core. Study coauthor Viktor Struzhkin explains: "The deeper you go, the higher the pressures and temperatures become. Under these extreme conditions, the atoms and electrons of the rocks become squeezed so close together that they interact very peculiarly. In fact, spinning electrons in iron, which is prevalent throughout the inner Earth, are forced to pair up. When this spin state changes from unpaired electrons—called a high-spin state—to paired electrons—a low-spin state—the density, sound velocities, conductivity, and other properties of the materials can change. Understanding these conditions helps scientists piece together the complex puzzle of interior/surface interactions."

The pressures in the lower mantle are brutal, ranging from about 230,000 times the atmospheric pressure at sea level (23 gigapascals) to almost 1.35 million times sea-level pressure (135 GPa). The heat is equally extreme—from about 2800 to 6700°F (1800 to 4000 K).

Using a laser-heated diamond anvil cell to heat and compress samples, the scientists subjected the mineral ferropericlase to almost 940,000 atmospheres and 3140°F (2000 K). As its name suggests, ferropericlase is iron laden. It is also the second most prevalent material found in the lower mantle. The researchers analyzed it using so-called X-ray emission spectroscopy. Previous to this study, ferropericlase had been subjected to high pressures, but only room temperatures. The new experiments used the highest pressures and temperatures attained to probe the spin state of iron in the mineral at lower-mantle conditions.

Under the less intense conditions of previous experiments, the high-spin to low-spin transition occurs in a narrow pressure range. In the new study, however, both spin states *coexisted* in the same crystal structure and the spin transition was continuous over a large pressure range, indicating that the mineral is in a complex state over a large range of depth in the planet.

"We were expecting to find a transition zone but did not know how extended it may be in the Earth's mantle," commented Struzhkin. "Our findings suggest that there is a region or 'spin-transition zone' from about 620 miles to 1,365 miles deep, where high-spin, unpaired electrons transition to low-spin, paired electrons. The transitioning appears to be continuous over these depths. At pressures representing a lower depth of about 1,365 miles, the transition stops and ferropericlase is dominated by low-spin electrons."

Since measurements that scientists use to determine the composition and density of the inner Earth—such as sound velocities—are influenced by the ratio of high-spin to low-spin states, the new finding calls into question the traditional techniques for modeling this region of the planet.

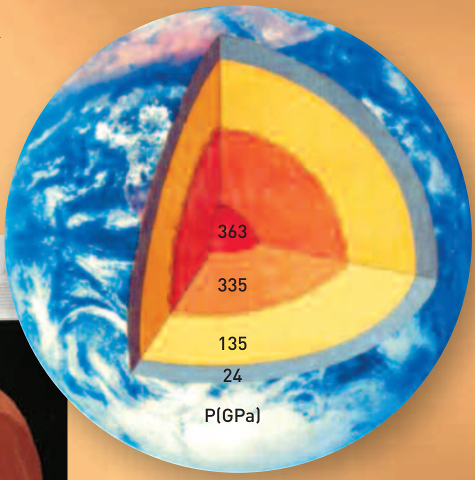
In addition, a continuous spin-transition zone may explain some interesting experimental findings—including why there has been no significant iron partitioning, or separating, into ferropericlase or perovskite, the most prevalent mineral in the region. The research also suggests that the depth of the transition zone is less than scientists had speculated.

The existence of this transition zone may also account for seismic-wave behavior at those depths. The fact that the lower-most area is dominated by denser low-spin material could also affect the temperature stability of mantle upwellings—the generators of volcanic hotspots, such as that of Hawaii. ☐

The work was published in the September 21, 2007, issue of *Science*.

Viktor Struzhkin, coauthor of the study, is interested in condensed matter physics, simple molecular solids, the chemistry and physics of the Earth's mantle and core, and high-pressure materials science.

(Image courtesy Viktor Struzhkin.)

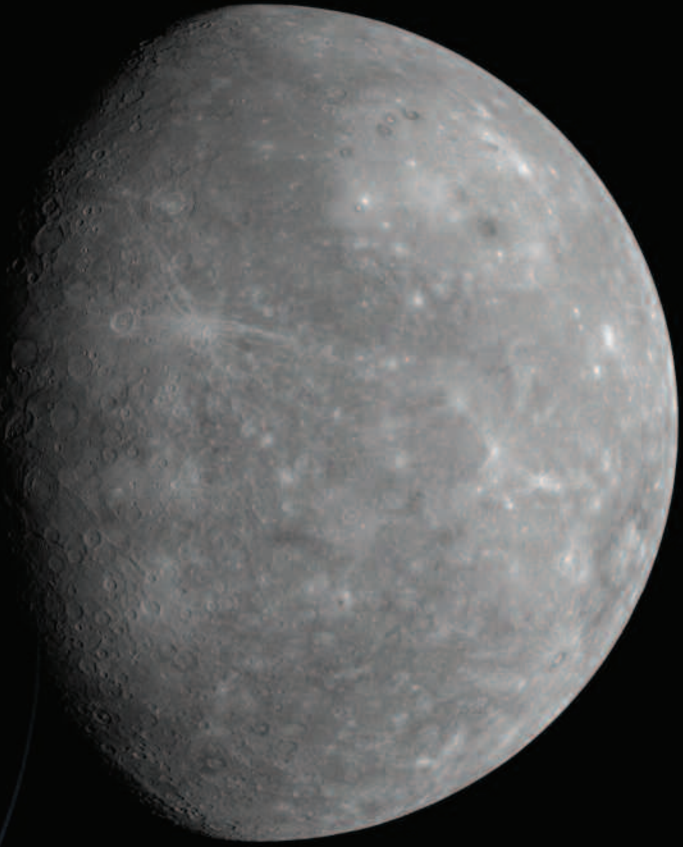


As depth increases in the planet, so do temperature and pressure. In this diagram the crust and upper mantle are grey, the lower mantle is yellow, the outer core is orange, and the inner core is bright orange. The pressure between the upper and lower mantle is about 23 GPa (or about 230,000 times atmospheric pressure at sea level). At the base of the lower mantle, the pressure is an intense 135 GPa (1.35 million times sea-level pressure).

(Image courtesy Russell Hemley.)

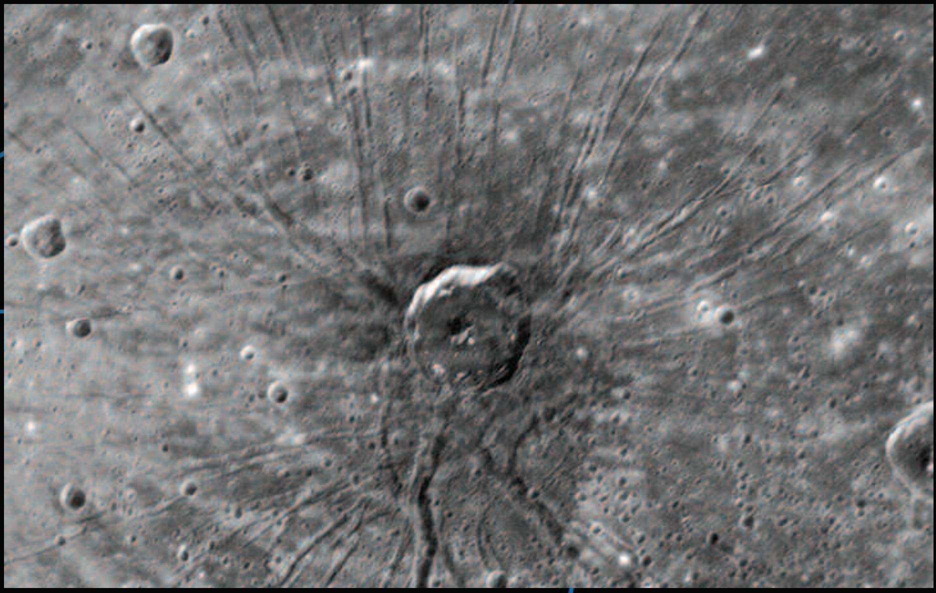
IN ADDITION TO CARNEGIE, THE DEPARTMENT OF ENERGY/BASIC ENERGY SCIENCES SUPPORTED THIS WORK. AUTHORS ON THIS PAPER ARE JUNG-FU LIN, LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL); GYÖRGY VANKÓ, KFKI RESEARCH INSTITUTE FOR PARTICLE AND NUCLEAR PHYSICS AND THE EUROPEAN SYNCHROTRON RADIATION FACILITY; STEVEN JACOBSEN, NORTHWESTERN UNIVERSITY; VALENTIN IOTA, LLNL; VIKTOR STRUZHKIN, CARNEGIE INSTITUTION'S GEOPHYSICAL LABORATORY; VITALI PRAKAPENKA, UNIVERSITY OF CHICAGO; ALEXIE KUZNETSOV, UNIVERSITY OF CHICAGO; AND CHOONG-SHIK YOO, LLNL.

RENDEZVOU



(Right) This is the first image ever taken by a spacecraft of Mercury's "other side." MESSENGER sent it back to Earth on January 15th. It was taken about 80 minutes after the tiny craft's closest approach to Mercury (2:04 p.m. EST January 14, 2008), when the probe was at a distance of about 17,000 miles (27,000 kilometers). The smallest features are about 6 miles (10 kilometers) in size. Like the other side of Mercury, which was previously mapped by Mariner 10, this hemisphere is heavily cratered, with some unique features. The giant Caloris basin is on the upper right; its western portions had not been imaged by a spacecraft before. Its diameter has been revised upward from about 800 miles, estimated on the basis of Mariner 10 images, to as great as 960 miles. Caloris was formed by a large asteroid or comet impacting the planet and is one of the largest and among the youngest basins in the Solar System.

(Below) MESSENGER imaged this unique feature, nicknamed "the spider" by the science team, near the center of the Caloris basin. The radiating troughs are unlike anything seen before. They are thought to have resulted when floor material, which filled Caloris after it formed, was stretched and fractured. In the center of "the spider" is an impact crater about 25 miles (40 kilometers) in diameter. The straight portions of the crater walls may have been influenced by preexisting troughs, or some troughs may have formed when the crater was initially excavated. As the science team analyzes the feature in more detail, they hope to determine the sequence of events in this intriguing region.



(Images courtesy NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.)

S WITH MERCURY

January 14, 2008.

At 2:02 p.m. mission controllers at The Johns Hopkins University Applied Physics Laboratory, in Laurel, Md., asked the crowd to hush. The din dwindled as scientists, engineers, reporters, and guests stared at the monitors and waited for MESSENGER to call back home. It had been over 40 minutes since the tiny spacecraft had been in touch with its handlers. The probe was behind the planet, flying toward its closest approach, about 124 miles (200 kilometers) above the surface, and taking the first pictures and other measurements that any craft has ever obtained of that half of the remote world. Controllers erupted into cheers and applause as the signal returned. MESSENGER, the MErcury Surface, Space ENvironment, GEochemistry, and Ranging craft, had successfully completed its first flyby of Mercury and made history.

More than 2.2 billion miles and three and a half years since its departure from Earth, MESSENGER got its first close-up glimpse of the planet that it will begin to orbit in mid-March of 2011. But for Sean Solomon, principal investigator of the mission and director of Carnegie's Department of Terrestrial Magnetism, the trip has been much longer. He and his team had their sights on returning to the first rock from the Sun for years. Their initial proposal for the MESSENGER mission was submitted to NASA in 1996.

The only previous spacecraft to visit Mercury was Mariner 10. But it was a flyby mission in 1974 and 1975 and was able to image slightly less than half the planet. Although that mission yielded tremendous data—it's how we know most of what we do of that tiny world—it also brought up more questions than the technology of the era could answer. Science needed an orbiter and the technology to withstand the searing conditions close to the Sun. Moreover, the ingenious trajectory that could slow the craft sufficiently for insertion into orbit about Mercury would not be available for another decade.

Thirty-three years is a long time to wait for a return to Mercury, but nothing is easy in the space business. Although the MESSENGER craft had successfully done its job buzzing the planet in its fourth planetary braking maneuver, the science team would not receive the first data from the mysterious half of the planet until the next day. Three other spacecraft unexpectedly monopolized two of the three Deep Space Network communications stations at the same time Earth was expecting MESSENGER's first results. As Solomon says, these missions are not for the impatient. Finally, on the evening of January 15, the eagerly anticipated first image of the previously unseen side became available to the world.

As researchers began to pore over that image and the other incoming data, it was clear that all seven scientific instruments had worked flawlessly, producing a stream of surprises that the science team is feverishly analyzing. The 1,213 images conclusively show that the planet is a lot less like the Moon than many previously thought; it has features not seen anywhere else in the Solar System; and the magnetosphere—a protective bubble produced by the planet's magnetic field and a puzzle to scientists for decades—appears to be very different from what Mariner 10 discovered and first sampled almost 34 years ago. NASA held a press conference on the initial results January 30th, with Solomon at the helm.

To Solomon, the most intriguing aspect from the new data is that material from Mercury's surface, its magnetosphere, and its incredibly thin atmosphere are highly interactive—the planet is much more dynamic than visual images would lead anyone to believe.

But what the world found most interesting was a big splat—a spider-shaped gouge smack in the middle of the Caloris basin.

Continued on page 12 ▷

(Above left) Carnegie's Sean Solomon (second from left), principal investigator of the mission, presented an overview of the scientific results of the flyby at the January 30th NASA press conference. The results were covered by major and minor news outlets around the world. Press conference participants from left to right are: James Green, Director, Planetary Science Division, NASA Headquarters; Sean Solomon; Maria Zuber of MIT; Robert Strom of the University of Arizona; and Louise Prockter of The Johns Hopkins University Applied Physics Laboratory, which built the craft and runs the mission operations.

(Below) Principal investigator of the MESSENGER mission, Carnegie's Sean Solomon (left), answers questions from *Baltimore Sun* reporter Frank D. Roylance, during the flyby on January 14, 2008, in Mission Control at the Applied Physics Laboratory in Laurel, Md. Mission controllers and onlookers wait for the tiny craft to fly past Mercury and resume communications with Earth.

Mercury, continued from page 11

Caloris was formed by the impact of a large asteroid or comet and is one of the largest, and perhaps one of the youngest, impact basins in the Solar System.

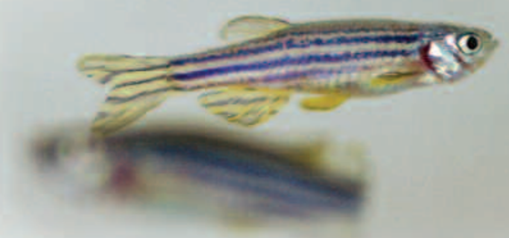
"It's unlike anything we've seen anywhere in the Solar System," remarked Solomon about "the spider." Centered on the unusual feature, which was nicknamed by the science team, is an impact crater about 25 miles (40 kilometers) in diameter. What happened to produce the geologic hodgepodge is currently a major topic of speculation. Science team member Maria Zuber of MIT suggests that "something pushed up" the basin. The researchers are looking into this and other tantalizing ideas.

What also came out of the brief encounter with the innermost planet is that it's highly pocked with impact scars, which are very different from craters on the Moon. Moreover, there is now no doubt that volcanism occurred on Mercury—a subject that had been debated. The researchers also think that as the particularly large core of the planet has cooled, the surface has contracted, producing the many ridges and scarps. But more on all of this is yet to come.

MESSENGER will travel more than six and a half years before it begins to orbit Mercury on March 18, 2011. It has two more Mercury flybys, one in October 2008 and the other in September 2009, before it can be inserted into orbit. By the end of its trip, it will have traveled 4.9 billion miles (7.9 billion kilometers).

"This first flyby was a huge success," offers Solomon, "and the observations we collected will keep the science team busy for many months. But we've also just begun the detailed planning for the second flyby in October. This mission is more of a marathon than a sprint, and we still have a long road in front of us, but it's very satisfying to have gathered the first spacecraft data from Mercury in more than three decades. It was particularly thrilling to stand in front of the computer monitors—along with colleagues with whom I've worked for more than a decade to make MESSENGER a reality—when the first images of the previously unseen side of Mercury were posted on the screens. Everyone in the room at that moment was an explorer of a new world." □

Tiny Fish Gives Science Education a Big Boost



An adult male zebrafish shows off his stripes.
(Image courtesy Bill Kupiec.)

Science has a new ambassador in Baltimore classrooms. Its formal name is *Danio rerio*, but the kids know it as the zebrafish. As junior scientists, students get to peer through a professional-level stereomicroscope to watch the zebrafish grow from a single-celled zygote to a larval fish complete with a beating heart.

The zebrafish comes to the schools courtesy of Project BioEYES, an innovative new program designed to foster an interest in and a love for science in elementary, middle, and high school students. It is the brainchild of Steven Farber, a developmental biologist and biochemist with the Department of Embryology, who uses zebrafish in his scientific research.

Named for their zebra-like stripes, the minnow-sized fish are inexpensive and easy to raise. They also share many genes with humans, a plus for scientists such as Farber, who studies the effects of genes on development of the digestive system.

A few years ago he discovered that the same qualities that make the fish useful for his research make them ideal for introducing children to the thrill of hands-on science.

"The fish develop from a single cell to a swimming larva within a few days," says Farber. "And during that period their bodies are optically transparent. You can watch their organs develop without harming the fish."

Farber started Project BioEYES in Philadelphia, where he was a professor at Thomas Jefferson University before coming to the Carnegie Institution in 2004. He was inspired by a visit to his son's elementary school, carrying along his fish, microscope, and other scientific gadgets to show the kids. "It was my first experience bringing a live science experiment to the classroom," he says. "Despite the challenges that face a new assistant professor and against the advice of some of my mentors, I became committed to developing a more formal outreach program."

That program became BioEYES, which he developed together with Jamie Shuda, a science educator. The name reflects the program's philosophy that the students are biological investigators, using their own eyes and minds to answer scientific questions.

Since its beginning in 2002, BioEYES has served more than 10,000 elementary through high school students in Philadelphia. "Demand for our program currently exceeds the number of weeks in the school year," notes Farber proudly. Hoping to build on this success, he approached the Carnegie administration with a plan to expand the program. Carnegie president Richard Meserve agreed to provide start-up funding, and with further support from local foundations, the Baltimore program launched in 2007.

Armed with fish, aquarium supplies, and a research-grade stereomicroscope, Carnegie educator Jessica Steele works with teachers in the classrooms to present the weeklong unit. On Monday, students are given the title "Junior Scientist" and, in groups of four, they are presented with a pair of fish, male and female. By Tuesday, the fish produce embryos that for the rest of the week the children will care for and observe. By Friday, the initial cluster of cells becomes a tiny fish with all its organs intact and a beating heart. Along the way, younger classes use the tools of science to learn the basics of cell division; older students do more complicated experiments in Mendelian genetics.

"All grade levels observe a beating heart," says Farber. "For many, this is their first glimpse at what is inside their own bodies." The impact is far beyond that of a picture or video.

Like the original program in Philadelphia, BioEYES in Baltimore targets schools serving economically disadvantaged and minority children. These students generally have few opportunities to experience live science and, as adults, tend to be underrepresented in science professions.

"We're trying to dispel the stereotype of a scientist as an old white guy in a lab coat with crazy hair," says Farber.

"Our mission is to help students see that they are in fact already scientists," adds Steele. "We want to get them excited about the possibilities of pursuing a career in science."

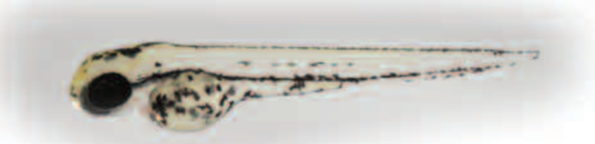
So far, the Baltimore program has introduced zebrafish to more than 300 students in six schools and is rapidly expanding, with hopes to reach at least 800 young scholars next year. Local funders such as the Abell Foundation, Clark Foundation, Hoffberger Foundation, and University of Maryland, Baltimore County, have kicked in support for BioEYES. Farber and Steele also have a major proposal in the works for long-term funding from the National Science Foundation.

But perhaps the biggest indicator of the program's success has been the enthusiastic response from students and teachers. All of the teachers report that they would do the program again, and a strong majority of the students voice the same opinion.

"Before Ms. Steele came, I didn't want to be a scientist," wrote one student. "I didn't because I thought that they only work at laboratories. But after I learned new things, I want to be a scientist." □

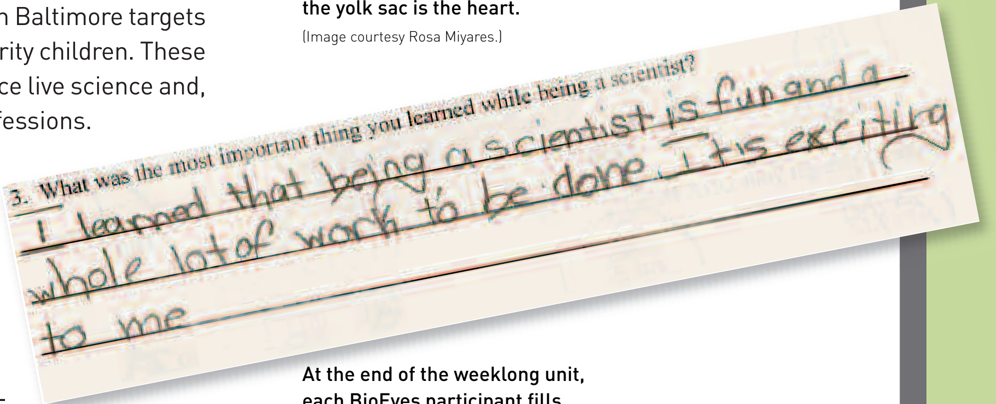
BioEYES "Junior Scientists" experience the excitement of scientific discovery by watching zebrafish develop in their Philadelphia classroom.

(Image courtesy Sharon Gekoski-Kimmel/ *Philadelphia Inquirer*.)



A three day-old zebra fish larva is transparent. The pink area visible between the big eye and the yolk sac is the heart.

(Image courtesy Rosa Miyares.)

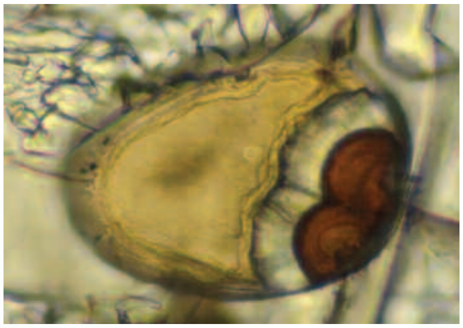


At the end of the weeklong unit, each BioEyes participant fills out a form, evaluating the program and reporting what they learned.

(Image courtesy of BioEYES.)

Final Answer: Building Blocks of Life Formed on Mars

The essence of all life on Earth comes in the form of organic compounds containing carbon and hydrogen. By analyzing organic material and minerals in one of the most famous Martian meteorites—Allan Hills 84001—scientists at Carnegie's Geophysical Laboratory (GL) have shown for the first time that building blocks of life formed on Mars early in its history. Scientists previously thought that the organic material in ALH84001 was brought to Mars by meteorite impacts or, perhaps, originated from ancient Martian microbes.



(Above) The brown and white globules in this microscope image are carbonate minerals in a sample from the Sverrefjell volcano of Svalbard. They contain organic compounds closely resembling similar globules in the Martian meteorite ALH84001. The image is 0.2 millimeters across.

(Image courtesy Hans E. F. Amundsen/AMASE.)

(Below) Norway's Sverrefjell volcano, at 80° N, erupted through a thick ice sheet about 1 million years ago.

(Image courtesy Kjell Ove Storvik/AMASE.)

The Carnegie-led team made a comprehensive study of the ALH84001 meteorite and compared the results with data from related rocks found at Svalbard, Norway. The Svalbard samples occur in volcanoes that erupted in a freezing Arctic climate about 1 million years ago—possibly mimicking conditions on early Mars.

"Organic material occurs within tiny spheres of carbonate minerals in both the Martian and Earth rocks," explained GL's Andrew Steele, lead author of the study. "We found that the organic material is closely associated with the iron oxide mineral magnetite, which is the key to understanding how these compounds formed."

The organic material in the rocks from Svalbard formed when volcanoes erupted under freezing conditions. During cooling, magnetite acted as a catalyst to form organic compounds from fluids rich in carbon dioxide and water. This event occurred under conditions where no forms of life are likely to exist. The similar association of carbonate, magnetite, and organic material in the Martian meteorite ALH84001 is compelling and shows that the organic material did not originate from Martian life-forms, but formed directly from chemical reactions within the rock. This is the first study to show that Mars is capable of forming organic compounds.

The organic material in the Allan Hills meteorite may have formed during two different events. The first, similar to the Svalbard samples, was during rapid cooling of fluids on Mars. A second event produced organic material from carbonate minerals during impact ejection of ALH84001 from Mars.

"The results of this study show that volcanic activity in a freezing climate can produce organic compounds," remarked coauthor Hans E. F. Amundsen from Earth and Planetary Exploration Services. "This implies that building blocks of life can form on cold rocky planets throughout the universe."

"Our finding sets the stage for the Mars Science Laboratory (MSL) mission in 2009," remarked Steele, who is a member of the team for the Sample Analysis on Mars instrument onboard MSL. "We now know that Mars can produce organic compounds. Part of the mission's goal is to identify organic compounds, their sources, and to detect molecules relevant to life. We know that they are there. We just have to find them." □

THIS RESEARCH WAS FUNDED BY THE NASA SRLIDA, ASTEP, NAI, AND ASTID PROGRAMS; THE MARSHALL SCHOLARSHIP PROGRAM; AND THE UNIVERSITY OF OXFORD DEPARTMENT OF EARTH SCIENCES. IT WAS CARRIED OUT IN COLLABORATION WITH THE ARCTIC MARS ANALOG SVALBARD EXPEDITION (AMASE) PROJECT.

InBrief

On Oct. 4 the Hillary Clinton presidential campaign rented the administration building for a Clinton speech about the importance of science. Carnegie president Richard Meserve was asked to introduce the candidate.

❶ David Lai

❷ Embryology business manager Susan Kern receives her award for 31 years of service.

Trustees and Administration

Carnegie president **Richard A. Meserve** chaired a symposium on energy and climate change at an American Academy of Arts and Sciences meeting Oct. 7 in Cambridge, MA. As a Harvard Overseer, he attended the installation ceremony on Oct. 12 for Harvard's new president, Drew Faust. On Oct. 16-17 Meserve attended the Carnegie Medal of Philanthropy ceremony in Pittsburgh and moderated a discussion with representatives of the Carnegie family of nonprofit organizations. He gave opening remarks for the Science Week 2007: Climate Action conference, held at the administration building Oct 22-24 and sponsored by the Norwegian Embassy. On Nov. 9 Meserve made a presentation at the US-Japan Workshop on Nuclear Energy in Washington, DC. He chaired a meeting of the IAEA's International Nuclear Safety Group in Vienna, Austria, Nov. 13-15, and a meeting of the National Academies' Nuclear and Radiation Studies Board, Dec. 12-14. Meserve traveled to the Las Campanas Observatory, Chile, Jan. 13-17, with a group of trustees and friends of the institution. He spoke at a memorial event honoring trustee emeritus William T. Golden, held on Jan. 25, sponsored by Carnegie, the AAAS, and the National Academy of Sciences. He also chaired a Jan. 31 meeting of the Agenda 2008 Study Group on Presidential Science and Technology Advisory Assets, a project of the Center for the Study of the Presidency.

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A number of new arrivals have joined the administration. The finance and accounting department welcomed **Shawn Frazier** in Oct. and **Singh Harminder** in Nov. **Alan Cutler** became the new science writer and publications coordinator in Oct. **Marlena Jones** joined CASE as the DC Biotech coordinator in Nov., and **Rob Ellis** joined the IT staff as a web developer in Jan. 2008.

Embryology

Allan Spradling presented seminars at Rockefeller U., Florida State U., U. Maryland, and the Helen Hay Whitney 50th Anniversary Symposium. He also organized the Genetics Society of America meeting entitled "Genetic Analysis: Model Organisms to Human Biology," held Jan. 5-8. Graduate student **Anna Allen** of his lab defended her Ph.D. thesis on Sept. 11, 2007, and begins her postdoctoral studies at NIH in Mar.

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Steve Farber presented a seminar at the Johns Hopkins School of Medicine and was selected by the Pew Trust to participate in the 2007 AAAS Leadership Seminar. **Jessica Steele** was hired in Sept. as outreach educator to work with Farber, coordinating and implementing the department's science outreach program.

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Yixian Zheng gave an invited talk at the 2007 American Society for Cell Biology minisymposium entitled "Assembling Complex Cytoskeletal Structures." She also presented her work at Northwestern U. **Youngjo Kim** from U. Georgia recently joined the Zheng Lab.

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❶ **David Lai**, a student in the Ingenuity Project at Baltimore Polytech Institute and lab assistant in the Koshland lab, is a semifinalist in the Siemens Competition in Math, Science & Technology. The competition gives students an opportunity to achieve national recognition for scientific research projects that they complete in high school. Lai worked for the past two years with Koshland graduate student Margaret Hoang, studying how cells maintain genome integrity to understand how loss of genome integrity occurs in cancer and evolution.

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Former graduate student **Elçin Ünal** has left the Koshland lab to begin her postdoctoral work at MIT.

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❷ On Dec. 21, Allan Spradling presented the first employee recognition awards at the department's annual end-of-year celebration. Twenty-two employees were honored for their 10 or more years of service.

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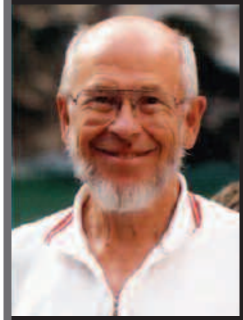
In Memoriam



Bob Rubin
(Image courtesy Vera Rubin.)

On January 18th, the Carnegie science community lost a friend with the death of mathematician and physicist, Robert Rubin, husband of Terrestrial Magnetism's senior fellow Vera Rubin. The Rubins were founding members of the Vannevar Bush Society, which recognizes individuals who contribute more than $100,000 to the institution. Several individuals contributed to the Carnegie Institution Memorial Fund in his memory. See http://www.ciw.edu/support/giving/in_memoriam for a brief biography.

2007 Louisa Gross Horwitz Prize

Joseph Gall was awarded the 2007 Louisa Gross Horwitz Prize, which he shared with Elizabeth Blackburn of UCSF and Carol Greider of JHMI. The prize was established by Columbia University to recognize outstanding contributions to basic research in biology and biochemistry. Allan Spradling and Carnegie board chairman Michael Gellert also attended the award ceremony.

The 2007 Horwitz awardees at the ceremony. From left to right: Carol Greider, Joseph Gall, and Elizabeth Blackburn.

❸ Seated at the microscope are Embryology department director Allan Spradling (left) and microscope specialist Mahmud Siddiqi (right).

❹ Participants (from left to right): architect **Lynne Iadarola**, **Roy Dingus**, **Russell Hemley**, **Ronald Cohen**, **Gary Bors**, and **George Cody.**

❸ The Department of Embryology has a new Leica SP5 laser scanning confocal microscope, which significantly enhances the department's imaging resources. The high-speed scanner can simultaneously capture up to six fluorescence channels in the visible and near-IR wavelengths. Embryology researchers look forward to imaging multiphoton fluorescence from thick specimens and live tissues—a new capability at the department. The purchase was funded jointly by the Howard Hughes Medical Institute and Carnegie.

Geophysical Laboratory

Christos Hadidiacos has been selected as the first recipient of the Carnegie Institution's new Service to Science Award. This award was created in 2007 to recognize outstanding and/or unique contributions to science by employees who work in administrative, support, and technical positions at Carnegie. Hadidiacos, an electronics engineer, has made invaluable contributions over a 42-year career, beginning with the arrival of the first electron microprobe at the Geophysical Lab.

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Lab director **Russell Hemley** presented an invited talk at the Joint 21st AIRAPT and 45th EHPRG International Conference on High Pressure Science and Technology in Catania, Italy, Sept.17-21. He also gave a talk at the 2007 GSA Annual Meeting and Exposition that took place in Denver, Oct. 28-31, and attended the AGU Fall Meeting to honor Lehmann Medal recipient Ho-kwang Mao on Dec. 12 in San Francisco. There, with Sean Solomon, he also cohosted a Carnegie alumni reception.

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Wes Huntress gave a National Research Council invited public talk at the Marshall Space Flight Center in Huntsville, AL, on Dec. 7 to celebrate the 50th anniversary of the space age. His essay on this anniversary of Sputnik was published in Russian and English by the Russian Academy of Science, and his book *Next Steps in Exploring Deep Space* was published by the International Academy of Astronautics.

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Staff scientist **George Cody** presented an invited seminar at the American Chemical Society meeting in Boston last fall. In Oct. he gave a seminar at U. Massachusetts, and in Dec. the Cody laboratory received a liquid chromatograph-tandem quadrupole mass spectrometer, supported by the W.M. Keck Foundation.

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Staff scientist **Bob Hazen** presented lectures on chemical steps to life's origins at Argonne National Laboratory, U. Delaware-Newark, and Carnegie's Department of Embryology. He served on the National Academy of Science's authoring committee for the booklet *Science, Evolution and Creationism,* with CASE's **Toby Horn**, released in Jan.

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Staff scientist **Ho-kwang (Dave) Mao** delivered a colloquium talk at the Chinese U. of Hong Kong on Nov. 23. He was invited to present several talks: one at the 5th International Workshop on Water Dynamics in Sendai, Japan, in Sept. 2007; another, a seminar, at the Joint 21st AIRAPT and 45th EHPRG International Conference on High Pressure Science and Technology in Catania, Italy, Sept. 17-21; and one at the Workshop on Advances in High Pressure Crystallography at Large Scale Facilities, Wadham College, at U. Oxford and Rutherford Appleton Laboratory, Sept. 3-7, 2007.

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Bjørn Mysen gave an invited lecture at U. Toronto on Nov. 22, entitled "Mineral/Melt Element Partitioning—How Can Melt Structure Help Us Understand the Influence of Melt Composition?"

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Jennifer Eigenbrode, lead PI, with colleagues from Carnegie, MIT, Goddard Space Flight Center, and Europe, has been awarded funding from the NASA ROSES Mars Fundamental Research Program for the study "Signatures of Life in Ice (SLIce): A Mars-Analog Investigation of the Molecular Signatures of Life in Superficial Glacial Ice." The three-year interdisciplinary study will help quantitatively understand organic matter preserved in ice to compare it with organic matter that might naturally occur in ice on Mars and help identify biosignatures of ice-dwelling life. These data will ground observations of Mars made by NASA's Phoenix Mars Mission and will help with instrument selection and data interpretation for future polar missions to Mars.

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Shaun Hardy attended the Geoscience Information Society annual meeting in Denver in Oct.

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Eugene Zhao arrived in Feb. as GL's new electronics engineer. Zhao has a Ph.D. in electrical engineering from George Mason U. He worked for five years in Silicon Valley in the microprocessor industry and was a design engineer at the National Key Lab on Microwave and Digital Communications in Beijing. Zhao will design and build electronic instruments, operate and train users on the electron microprobe and scanning electron microscope, solve electronics problems, and maintain smooth operation of instrumentation.

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❹ On Jan. 16, 2008, a number of GL staff visited the Howard Hughes Medical Institute at Janelia Farm Research Center in Ashburn, VA, to look at the new state-of-the-art facility.

Global Ecology

Chris Field was interviewed on NPR's *Science Friday* by Ira Flato regarding new climate solutions as CO_2 levels rise. He gave a keynote lecture on carbon emissions at the Norway-US Transatlantic Science Week conference and presented the keynote address at a US-France meeting on sensor development at the French Embassy, both in Washington on Oct 22. On Oct. 27 Field addressed the Eastern California District of the US District Court in Yosemite. He organized a session on impacts of climate change at a Hawaii symposium to commemorate 50 years of CO_2 measurements at Mauna Loa, Nov. 28-30.

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The Carnegie Airborne Observatory (CAO) team completed its largest aerial mapping campaign to date, with more than three months of flying in Hawaii. The team included **Greg Asner**, **Ty Kennedy-Bowdoin**, **David Knapp**, **Tim Varga**, **Robin Martin**, and many other collaborators.

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Ken Caldeira taught a course on energy and the environment during the fall quarter at Stanford U. On Oct. 4 he gave a seminar entitled "A Geological Perspective on Ocean Acidification from

2009 Dana Medal

Ronald Cohen will receive the 2009 Dana Medal of the Mineralogical Society of America. The announcement was made in Oct. at the Geological Society of America meeting in Denver. The Dana Medal "is intended to recognize continued outstanding scientific contributions through original research in the mineralogical sciences by an individual in the midst of their career."

NOBEL PEACE PRIZE

Global Ecology director **Chris Field** was chosen to be part of the IPCC delegation to receive the Nobel Peace Prize in Oslo on Dec. 10. Field poses with the Nobel Medal (above). The attending members of the IPCC group, plus former Vice President Al Gore (front row, middle) are standing (above right). Field is the first person at the left in the back row.

(Image courtesy Nobel Foundation.)

Greg Asner was recognized by *Popular Science* magazine as one of the ten most brilliant young scientists in the country.

Fossil-Fuel CO_2" at Stanford's Dept. of Geological and Environmental Sciences. He spoke to Carnegie's Department of Plant Biology about where forests warm, where they cool, and the carbon-cycle and biophysical influences of forests on climate.

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Several Carnegie researchers supported by the Global Climate and Energy Project participated in its 3rd Annual Meeting at Stanford, Oct. 1-3. **Chris Field** spoke about biofuels and bioconversion, and he chaired the session "Bioenergy Conversion and Energy Storage." **Ken Caldeira** spoke about geoengineering.

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In Oct. **Joe Berry** chaired the final session of a symposium honoring Carnegie's Plant Biology director, Chris Somerville, for his 60th birthday. **Chris Field** spoke about feedbacks of terrestrial ecosystems to climate change.

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Seventeen current and recent members of Global Ecology presented papers at the AGU meeting in San Francisco, Dec. 10-14. They were **Cristina Archer**, **Joe Berry**, **Ken Caldeira**, **Elliott Campbell,** **Long Cao**, **Nona Chiariello**, **Chris Field**, **Noel Gurwick**, **Ben Houlton**, **Choy Huang**, **Maoyi Huang**, **David Lobell**, **Roland Pieruschka**, **Ulli Seibt**, **Carolyn Snyder**, **Yingping Wang**, and **Adam Wolf.**

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The Jasper Ridge Datafest was held on Dec. 15. Presenting were **Nona Chiariello**, **Paul Dykstra**, **Yuka Estrada**, **Noel Gurwick**, **Ben Houlton**, **Bruce Hungate**, **Paul Leadley**, **Claire Lunch**, and **Ted Raab**. They covered a variety of experiments at the site and with soils and in the lab.

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Former Field lab technician **David Kroodsma** finished his second Ride for Climate USA, bicycling from Boston/New York to Stanford. He also spoke at a seminar at Global Ecology. His first tour was from Stanford to the southern tip of South America.

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Arrivals: Kyla Dahlin, Stanford grad student, began working for the Asner and Field labs on Sept. 24, 2007. **Luis Fernandez** of the Environmental Protection Agency is a visiting researcher at Global Ecology and Stanford. He uses geographic information systems to study biofuels and land cover.

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Departures: Two lab technicians left the Field Lab: **Christian Andreassi** and **Kelly Gleischman.**

Observatories

Observatories director **Wendy Freedman** attended the Science the Next Frontier Kavli Symposium in Santa Barbara, CA, on Sept. 15, in celebration of Fred Kavli's 80th birthday. She gave an invited colloquium, "Measuring Cosmological Parameters," at Stanford U. on Sept. 25. Freedman gave the banquet talk on "The Giant Magellan Telescope" at the 2nd Magellan Science Symposium, Harvard-Smithsonian CfA, Oct. 29, and presented results on the Carnegie Supernova Project.

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❺ Director emeritus **George Preston** gave the first talk at a Princeton U. symposium honoring Bohdan Paczynski, Sept. 29-30. He repeated that talk at

The Global Ecology research building won another design award. It was one of three 2007 Livable Buildings Award winners from the Center for the Built Environment.

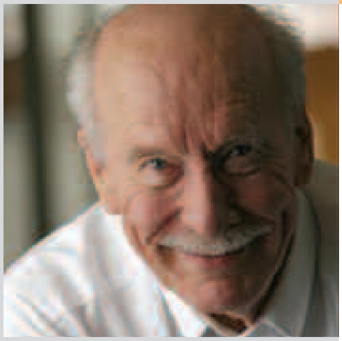
(Image courtesy Peter Aaron/Esto Photographics.)

2008 Jackson-Gwilt Medal

The Royal Astronomical Society awarded **Stephen Shectman** the 2008 Jackson-Gwilt Medal for his exceptional work in developing astronomical instrumentation and constructing telescopes. Shectman was the project scientist for Carnegie's twin Magellan 6.5-meter mirror telescopes at Las Campanas, Chile, and has designed and built many of its instruments. He is a driving force behind the Giant Magellan Telescope project.

In addition to developing tools for studying celestial objects, Shectman investigates galaxies and stars. In particular, he studies the large-scale structure of the galaxy distribution and searches for ancient stars with very low abundances of the heavier elements.

Carnegie astronomer and 2008 Jackson-Gwilt Medal winner Steve Shectman



❺ Director emeritus of the Observatories, George Preston

In Dec. Miguel Roth, director of the Las Campanas Observatory, participated in a seminar about astronomy in Chile, organized by the Chilean Ministry of Foreign Affairs. The first day of the symposium was devoted to high school students, some of whom are pictured with Roth at left.

the Copernicus Inst., Warsaw, Poland, and delivered a second lecture about a unique metal-poor stellar binary system at the Warsaw U. Observatory.

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In Dec. staff astronomer **Steve Shectman** chaired the review for the Binospec instrument being built at the CfA for use on the MMT telescope.

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Staff astronomer **Luis Ho** gave lectures at Wuhan U. and Peking U. He gave an invited talk at a meeting in Tucson, AZ: "Galaxy and Black Hole Evolution: Towards a Unified View."

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In Sept. staff astronomer **Michael Rauch** gave an invited talk in Garching, Germany, at the conference on Gas Accretion and Star Formation in Galaxies. In Dec. he gave an invited review about the intergalactic medium at the Cosmic Cartography conference in Chicago and presented a poster on faint high-redshift galaxies at a conference in Hayama, Japan.

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In Oct. Carnegie-Princeton Fellow **Inese Ivans** gave a talk on chemical composition of metal-poor stars as part of the IXth Torino Workshop on Evolution and Nucleosynthesis in AGB Stars and the IInd Perugia Workshop in Nuclear Astrophysics in Italy.

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Janice Lee, Carnegie Fellow, gave an Oct. talk at the Formation and Evolution of Galaxy Disks conference in Rome; in Nov. she gave the colloquium "Constraints on the Dwarf Galaxy Starburst Duty Cycle" at the U. of Washington. She participated in Nov. in commissioning observations using the NOAO Extremely Wide-Field Infrared Imager (NEWFIRM), a new instrument at the 4-meter telescope at Kitt Peak.

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Spitzer Fellow **Jane Rigby** gave an invited talk at the New Horizons in Astronomy symposium, Oct. 16, in Austin, TX. She gave a talk at the Galaxy and Black Hole Evolution meeting in Tucson, AZ, Nov. 28-30.

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At the Observatories' "Science Day," Sept. 28, researchers summarized their latest work in a series of short, interactive talks. Staff scientist **Luis Ho** described new views into the movement of gas and stars around the central black holes of galaxies, and visiting scientist **Scott Burles** (MIT) summarized new prism instrumentation. New fellows **Janice Lee**, **Masami Ouchi**, and **Jesper Rasmussen** talked about star-bursting dwarf galaxies, the most distant galaxies, and the deaths of spiral galaxies in groups. Science Days are held every few months.

Plant Biology

Wolf Frommer presented a seminar in Sept. at a colloquium at San Francisco State U. and the plenary talk and a seminar at ComBio2007 in Sydney, Australia. He also presented lectures at U. New South Wales, Australia, and at the conference on Fluorescent Proteins and Biological Sensors at HHMI Janelia Farm. In Nov. he presented lectures at the Koerber Forum in Hamburg, Germany; the Systems Biology Department in Zurich, Switzerland; the Medical School at U. Bern, Bern, Switzerland; U. Regensburg, Germany; and the Dept. of Biochemistry at Stanford U. In Dec. Frommer gave the following presentations: a seminar at Cornell U.; a seminar at the Biofuels and Bioenergy: Developing the Infrastructure for Global Change minisymposium at the Boyce Thompson Institute for Plant Research, Cornell U.; and a seminar at the U. Minnesota Microbial and Plant Genomics Institute's Leading Edge Technologies seminar series.

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Winslow Briggs presented the keynote address at a Sonderforschungsbereich Biophysics Symposium at Free U. of Berlin in Sept. He also presented an Oct. lecture at the Plant Gene Expression Center of the USDA and U. California, Albany, CA. In Dec. Briggs was invited to be a member of a group of advisors to evaluate various principal investigators at the Institute of Plant and Microbial Biology, Academia Sinica, Taipei, Taiwan.

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In Sept. **David Ehrhardt** presented the plenary talk and symposium talk at ComBio2007 in Sydney, Australia; gave a seminar at Australian National U. in Canberra, Australia; and spoke at the Plant Cell Biology Symposium at the Max Planck Institute in Cologne, Germany. In Nov. Ehrhardt was a speaker at the Biobased Industry Outlook Conference in Ames, IA.

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Zhi-Yong Wang presented a lecture at U. Delaware in Nov.

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Eva Huala presented a lecture at the Nov. conference on Genome Informatics at Cold Spring Harbor Laboratory.

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Shaun Bailey, a postdoctoral research associate in Arthur Grossman's lab, presented a talk on electron transport in marine photosynthesis at the 17th Western Photosynthesis Conference, where he was also awarded the Richard Malkin

Changing of the Guard at Plant Biology

On December 1, 2007, Chris Somerville, director of Plant Biology since 1994, became the first director of the Energy Biosciences Institute (EBI)—a new research and development organization with an interdisciplinary approach to solving global energy needs and reducing fossil-fuel emissions that contribute to global warming. It is the first research institution dedicated to the new field of energy bioscience. EBI is a consortium with BP, UC-Berkeley, Lawrence Berkeley National Laboratory, and U. Illinois. BP is supporting EBI with a 10-year, $500 million grant. Staff member Wolf Frommer, at Carnegie since 2003, is the acting director of the department.

Wolf Frommer

Chris Somerville

Fernando Peralta, a telescope operator at Carnegie's Las Campanas Observatory, retired in late Nov. after 38 years of continuous service. The staff celebrated with a barbecue. Peralta received astronomical binoculars as a gift.

❻ Pembroke Hart

Award for outstanding contributions to photosynthesis research.

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Tanya Berardini, **David Swarbreck**, and **Peifen Zhang**, postdoctoral associates in **Seung Rhee**'s lab, presented seminars in Oct. at the 2nd International Biocuration Meeting in San Jose, CA. Postdoctoral associates **Philippe Lamesch** and **Donghui Li**, in the lab, presented seminars in Jan. at the Plant and Animal Genome XVI Conference in San Diego.

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Arrivals: The Frommer lab welcomed three new arrivals: visiting fellow **Christine Chang** from Stockholm U. on Oct. 10, postdoctoral research associate **Li-Qeng Chen** from China Agricultural U. on Nov. 16, and lab technician **Maria Sardi**, also on Oct.10. Postdoctoral research associate **Wen-Hui Lin** from UC-Berkeley joined Zhi-Yong Wang's lab on Dec. 3. Sue Rhee's TAIR group was joined by junior software engineers **Raymond Chetty** on Oct. 1 and **Cynthia Lee** on Oct. 15. **Kate Dreher** joined the group on Nov. 1 as a curator and, on Nov. 12, **Suzanne Fleshman** came as an assistant curator. **Maria Gómez-Garcia** from Stanford U. joined Devaki Bhaya's lab as a postdoctoral research associate on Oct. 17. **Allison Phillips** joined Matt Evans's lab as a postdoctoral research associate from U. Wisconsin-Madison. The administrative staff welcomed accounts payable assistant **Turkan Eke** on Oct. 16.

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Departures: Postdoctoral research associate **Seth DeBolt** departed Chris Somerville's lab Dec. 17 to take an assistant professor position at U. Kentucky. **Natalie Khitrov**, a lab technician in that lab, took a position at Stanford U. on Dec. 1. **Rieko Nishimura**, a postdoctoral research associate in Shauna Somerville's lab, left on Dec. 31. Postdoctoral research associate in the Grossman lab, **Chao-Jung Tu**, also left on Dec. 31. **Thomas Walk**, a postdoctoral research associate, left the Rhee lab on Oct. 1.

Terrestrial Magnetism

Sean Solomon chaired a review panel for the NSF Ocean Observatories Initiative in Oct., and he served on the visiting committee to the Harvard-Smithsonian CfA in Dec. In Nov. he made presentations on the MESSENGER mission to the NASA Goddard Extrasolar Planets Club, to the NASA Venus Exploration Analysis Group, and at a symposium on "50 Years of the Space Age," held at the U. of Maryland-College Park. Solomon was featured in the worldwide media in connection with MESSENGER's Mercury flyby in Jan. Coverage included radio programs on NPR and Planetary Radio.

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Alan Boss lectured on new worlds at the Bicentennial Conference of the Geological Society of London, chaired the NASA Origins of Solar System Review Panel meeting in Salt Lake City, and talked about Solar System formation at the NASA Goddard Space Flight Center in Sept. In Nov. he attended a Science Team meeting for NASA's Kepler Mission in Boulder and gave an invited briefing on giant planet formation to the Science Mission Directorate at NASA. In Jan. Boss gave two lectures on planet formation at the Winter School on Exoplanets, held at National Tsing Hua U. in Taiwan.

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In Sept. and Oct. **John Chambers** gave talks on planet formation and migration at the U. of Florida in Gainesville, and at the U. of Texas-Austin.

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Larry Nittler attended the Workshop on the Chronology of Meteorites and the Early Solar System in Kauai, HI, in Nov. He gave an invited talk at the conference on the Origin of Matter and Evolution of Galaxies in Sapporo, Japan, in Dec.

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In Sept. **Alycia Weinberger** worked with American U. student **Johanna Teske** on her senior project in physics, analyzing gas around shell stars that may be debris disks.

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Postdoctoral associate **John Debes** gave two talks at the American Astronomical Society (AAS) in Jan. on circumstellar disks and white dwarfs. Also in Jan., as part of the AAS Committee on the Status of Women in Astronomy, he participated in a panel on having children at different stages of one's academic career.

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Postdoctoral associate **Maureen Long** spoke on seismic anisotropy at the Smithsonian National Museum of Natural History's Department of Mineral Sciences in Dec.

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David James, field seismologist **Steven Golden**, postdoctoral associate **Maureen Long**, and visiting investigator **Matt Fouch** spent several weeks in eastern Oregon in Sept. and Oct. installing broadband seismometers as part of the High Lava Plains seismic experiment.

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Postdoctoral fellow **Alceste Bonanos** gave talks at the Symposium 250 meeting at the International Astronomical Union in Kauai in Dec.

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The 39th Division for Planetary Sciences meeting was held in Orlando in Oct. **Sean Solomon**, **Alan Boss**, and visiting investigator **Sergei Ipatov** gave presentations.

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Sean Solomon and librarian **Shaun Hardy** participated in the 2007 Annual Geological Society of America Meeting in Denver in Oct.

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The 2007 American Geophysical Union Fall Meeting was held in San Francisco in Dec. Several DTM staff and postdoctoral fellows presented, including **Sean Solomon**, **David James**, **Rick Carlson**, **Erik Hauri**, **Steve Shirey**, **Paul Silver**, postdoctoral fellows **Natalia Gómez Pérez**, **Maureen Long**, **Thomas Ruedas**, **Liping Qin**, **Alex Song**, **Jessica Warren**, and **Wen-che Yu**.

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DTM welcomed several new postdoctoral fellows this fall and winter. **Natalia Gómez Pérez**, formerly of the U. Alberta, **Cathy Slesnick**, formerly of Caltech, and **Wen-che Yu**, formerly of SUNY-Stony Brook, arrived in Oct. **Jessica Warren**, formerly of MIT and the Woods Hole Oceanographic Institution, arrived in Jan.

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Postdoctoral fellows **Lara Wagner** and **Ivan Savov** departed DTM in Oct. and Dec., respectively. In Jan. Wagner began a faculty position at UNC-Chapel Hill, and Savov started a lectureship at U. Leeds, UK.

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❻ **Pembroke J. Hart**, DTM predoctoral fellow from 1952 to 1954, died on Feb. 6. Hart worked on seismic studies with Howard E. Tatel and former DTM director Merle A. Tuve. He returned as a visiting investigator in 1965 as part of the Andean Seismic Expedition in Bolivia and Peru and again in 1968 for the East Coast Seismic Experiment. Hart received his Ph.D. in physics from Harvard in 1955. A service was held on Mar. 15 at St. John's Episcopal Church in Georgetown. □

The Global Ecology Fund-Raising Campaign

In the summer 2007 chairman's letter, Board Chairman Mike Gellert announced that Carnegie will be undertaking a campaign to secure more than $35 million to provide start-up funds and a permanent endowment to help the Department of Global Ecology meet its full potential in understanding the underlying mechanisms of ecological processes, such as those involved with climate change. (See pages 6 and 7.)

Marion O'Leary (Above)
Steve Fodor (Right)

Since that time, trustees and Global Ecology scientists have discussed the shape of the expanded department, and they have begun planning the fund-raising effort. Trustee Steve Fodor is serving as chairman of the campaign, and Marion O'Leary has joined the Global Ecology department as senior advancement adviser. Over the years, O'Leary has had a distinguished career in biochemistry and has been a research partner of departmental staff member Joe Berry. He also served as dean of the College of Natural Sciences and Mathematics and as Interim Vice President for Advancement at Sacramento State University.

Support for Global Ecology and its campaign continues to affirm the department's outstanding performance: research grants were received this fall from the Andrew W. Mellon Foundation and an anonymous donor. The Gayden Family Foundation and other contributors are also providing start-up funds. This campaign is off to a great start. Stay tuned for more progress reports. □

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