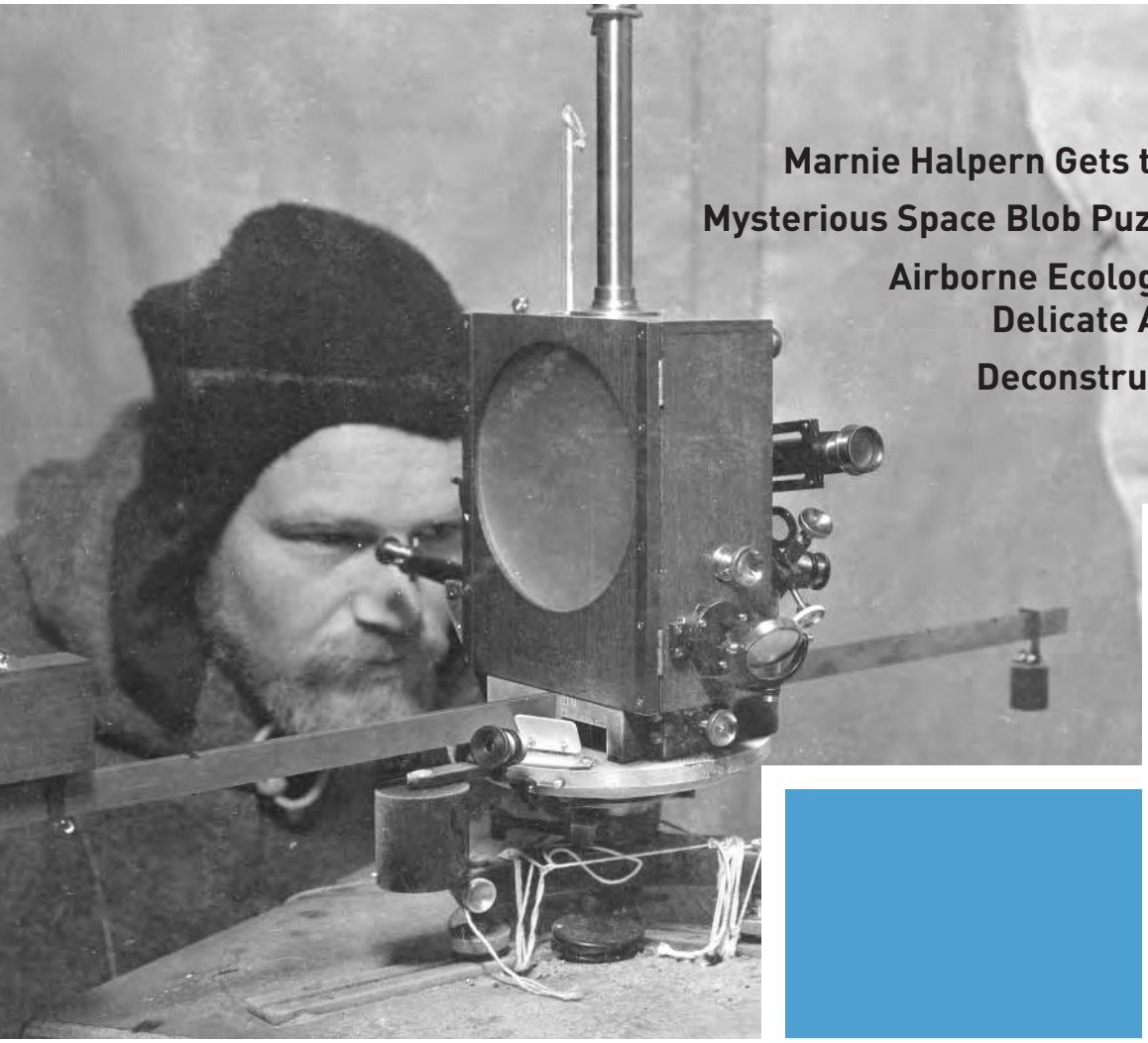
CarnegieScience

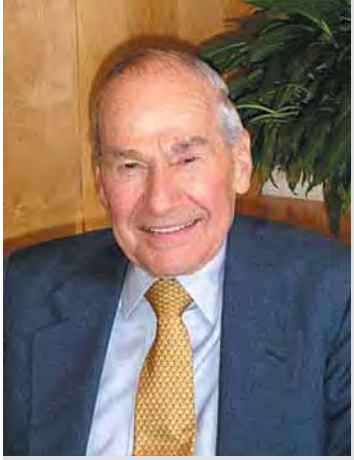
The Newsletter of the Carnegie Institution

SUMMER 2009

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



On the Inside



Nearly every scientific discovery is made possible by a dedicated support staff. Fortunately, Carnegie has an extraordinary array of these gifted individuals. Engineers, instrument makers and machinists, telescope operators, animal-care technicians, information technology experts, greenhouse and field-workers, laboratory personnel, facilities managers, business professionals, and even chefs work behind the scenes. Many of these staff members have masters or Ph.D.s. In 2007, Carnegie initiated the Service to Science Award to recognize the outstanding or unique contributions of these employees.

To understand the genes behind animal development, the Department of Embryology houses a variety of organisms for study. These animals require specialized care and feeding all year long in highly controlled conditions. This year Tom McDonaugh, the department's facilities manager, received a Service to Science Award for his extraordinary work keeping the old Embryology building functional and ensuring the completion and smooth operation of the new Singer Building, including the reengineering of some of these critical animal habitats. Animal-care technicians, including Michelle Macurak and Jen Anderson, keep these valuable creatures healthy 24 hours a day, seven days a week.

The Broad Branch Road campus, which houses the Geophysical Laboratory (GL) and the Department of Terrestrial Magnetism (DTM), hosts a diverse group of scientists. Recently, the GL business office was transformed by Jeff Lightfield into a well-oiled machine to support GL science. Some GL researchers depend on specialized devices to squeeze samples for analysis and use sophisticated imaging to view the results. People like Bobbie Brown and Steve Coley meet these specialized instrument needs. Retired GL electronics engineer Christos Hadidiacos was important to the department for over 42 years and was the first to receive the Service to Science Award.

DTM researchers use state-of-the-art instrumentation for their science. Machinists and instrument makers are on hand for precision work, and laboratory managers Tim Mock, Mary Horan, and Ben Pandit are critical to keeping instruments in top running order. Michael Acierno, another recent winner of the Service to Science Award, has developed software and programmed innovative hardware to support astronomy, seismology, and vulcanology.

Plant Biology and Global Ecology share a campus at Stanford University. Much of the genetics research at Plant Biology is at the bench and relies on the detailed, meticulous work of their lab technicians. Greg Asner's group at Global Ecology takes the one-of-a-kind instruments of the Carnegie Airborne Observatory to some of the remotest regions on the planet. Programmers David Knapp and Ty Kennedy-Bowdoin, among others, are key to this globe-trotting research.

The Observatories spans two continents. In Pasadena, 30-year veteran facilities manager Steve Wilson supervises building and ground maintenance and oversaw the renovation of the historical Hunt Building. In the front office, Silvia Hutchison arranges meetings and events, coordinates with Magellan and GMT partners, and performs a dizzying array of other administrative tasks as the right-hand assistant to the director.

The remote Las Campanas Observatory in Chile is a town in itself, complete with the infrastructure to support the telescopes and a legion of observers. Alan Bagish, Magellan electronics engineer, develops and maintains the electronics for instruments at the Magellan telescopes. He repairs instruments and works with new software for upgrades.

Support personnel in Washington are also vital. They manage the endowment, oversee the budget, and much more. Our staff researchers would be the first to tell you that their science could not happen without these collaborators. The diversity of talent across the institution is impressive and will continue to be essential to our success.

Michael E. Gellert, *Chairman*

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The Carnegie board of trustees held their 130th meeting May 7 and 8 at the Washington, D.C., administration building. The Employees Affairs, Finance, and Development committees met May 7, followed by the first session of the board. That evening chairman of the board Michael Gellert and Carnegie president Richard Meserve hosted the annual dinner to honor members of Carnegie's philanthropic societies and to thank donors for their generous contributions.

John Holdren, Assistant to President Obama for Science and Technology and Director of the White House Office of Science and Technology Policy, spoke to the audience after dinner about the new directions the administration is taking in science and technology. Secretary of Energy Steven Chu was among the guests and joined in the informal question-and-answer period after Holdren's remarks. Then, staff scientist Bob Hazen of the Geophysical Laboratory and Pamela Sverjensky, chair of the piano department at the Levine school, performed a musical tribute to end the evening.

The next day the Budget and Nominating committees met, followed by the second session of the board. The full board unanimously elected two new trustees, Samuel Bodman and Rush Holt.

John Holdren (left), Assistant to President Obama for Science and Technology and Director of the White House Office of Science and Technology Policy, spoke after dinner. He and Carnegie president Richard Meserve converse.

From left to right, Secretary of the Board Deborah Rose, Honey Nashman, Jim Weinberg, Chairman of the Board Michael Gellert and Secretary of Energy, Steven Chu, enjoy the evening's entertainment.

Staff scientist Bob Hazen of the Geophysical Laboratory and Pamela Sverjensky, chair of the piano department at the Levine school, performed a musical tribute to end the evening.

Images courtesy Jim Johnson

Carnegie Welcomes Bodman and Holt to the Board of Trustees

Former Secretary of Energy Samuel Bodman (left) and Congressman Rush Holt (right) of New Jersey were unanimously elected to the board of trustees May 8.

Images courtesy du Pont, and Representative Rush Holt's office

Former Secretary of Energy Samuel W. Bodman and Congressman Rush Holt of New Jersey were unanimously elected to the board of trustees on May 8. In addition to distinguished careers in public service, both men have impressive scientific backgrounds.

Bodman received a B.S. in chemical engineering from Cornell and an ScD from MIT, where he became an associate professor of chemical engineering for six years. He then transferred to the financial sector, working for the venture capital firm American Research and Development Corporation, serving as technical director. In 1983 Bodman became president and chief operating officer of Fidelity Investments and a director of the Fidelity Group of Mutual Funds. He joined the Cabot Corporation in 1987 to serve as chairman.

In 2001, Bodman was appointed Deputy Secretary of the Department of Commerce in the Bush administration. He later served as Deputy Secretary of the Treasurer and became the 11th Secretary of Energy in 2005. Over the years he has served on numerous boards and been active in other public service.

Rush Holt is the Democratic representative from the 12th District of New Jersey and a physicist by training. He received both an M.S. and Ph.D. in physics from New York University. He has been a teacher and a Congressional Science Fellow, and has served at the U.S. State Department as an arms control expert monitoring nuclear programs. He was also the assistant director of the Princeton Plasma Physics Laboratory from 1989 until his campaign for Congress in 1998. Among his many achievements, he was instrumental in securing more than $22 billion in new federal funding for science and technology in the stimulus legislation.

Holt is particularly interested in research on alternative energy and holds a patent for a solar energy device. He has received numerous awards, including the Biotech Legislator of the Year and the Science Coalition's Champion of Science award. *Scientific American* named him one of the 50 national "visionaries" contributing to "a brighter technological future." □

Marnie Halpern GETS THE Left Side Right

The red labeling in this image shows molecular differences between the left and right sides of the larval zebrafish.
Image courtesy Yung-Shu Kuan

One can't help wondering if Embryology's Marnie Halpern was smitten by the asymmetry of the brain, at least in part, because she is the lone southpaw among six siblings. In this year's Carnegie Evening lecture, Halpern took the audience on a tour of how the brain develops into two unequal hemispheres and what stimulates the puzzling difference.

By splashing advertisements on the screen, Halpern began by emphasizing that even popular culture recognizes that the two halves of the human brain are structurally and functionally different. Language predominately resides in the left hemisphere, and some 90% of humans are right-handed. But is this asymmetry uniquely human? Science has shown that it is not.

Halpern presented numerous examples of lateralized behaviors in nature. Some snakes, for instance, coil in a clockwise direction. Certain toolmaking birds prefer using their devices on one side when they excavate food, and walruses and dolphins show biases in which flipper they use. Not only is asymmetry not exclusive to humans, but other creatures exhibit laterality at the population level, which may have an evolutionary advantage. And it is all governed by the brain.

Focusing on her own work, Halpern turned to her research organism, the tiny zebrafish *Danio rerio*. A prolific breeder and easy to maintain, the young fish are entirely transparent, which is useful for watching when and where genes turn on to control development.

While studying a genetic mutation in a gene called *cyclops,* which causes a single fused eye to form, Halpern and colleagues found that the protein, nodal, made by that gene is responsible for setting the direction of brain asymmetry. The nodal signal was already known to control the asymmetry of our internal organs, and recently, the laboratory of former Embryology staff associate Nipam Patel, now at the University of California at Berkeley, found that it even plays a role in the directional coiling of snail shells. Without the protein the snail shell doesn't coil properly, and in the zebrafish, both sides of the brain develop as if they were the right side.

Halpern noted that later in development nodal affects the position of a part of the brain called the pineal organ, which is set off slightly to the left. That's where day/night and seasonal rhythms are controlled. A smaller structure associated with the pineal, the parapineal, further governs left side development. The researchers found that if the parapineal is disrupted, nerve cells on the left side of the brain and their neural connections are affected. Their results indicate that left-right differences occur in a step-by-step fashion.

By manipulating gene activity, the researchers have developed two populations of zebrafish—normal brained and reverse brained—to see if the reverse-brained animals exhibit behavioral differences. They do. When tested in tanks with mirrors, the curious normal-brained fish swim around excitedly, exploring along the way. The reverse-brained fish appear lethargic and uninterested in their environment. So what does this mean? There may be a lot more to sidedness than first meets the eye—brain asymmetry may be integral to regulating complex behaviors, such as fear or motivation. □

Marnie Halpern (left), with Carnegie president Richard Meserve and Marnie's mother, Clara, pose before the evening's lecture.


Tom McDonaugh


Michael Acierno

Two Receive Service to Science Awards

Prior to the evening's lecture, Carnegie president Richard Meserve recognized two new recipients of Carnegie's Service to Science Award. He emphasized that supporting the exceptional scientist is not just monetary support: "It also means tools, devices, instruments, and buildings—the things that allow research to proceed. And, it means people who know how to make the tools, devices, instruments, and buildings work." The award was inaugurated in 2007.

This year's recipients are Terrestrial Magnetism's (DTM) Michael Acierno and Embryology's Tom McDonaugh. Michael Acierno is an IT/IS Manager/Systems Engineer at DTM and for over two decades he has contributed to research in astronomy and geophysics through maintaining and advancing an array of very different computer-related systems. Meserve noted that Acierno was a good "budgetary steward," who extracted "the most from our assets."

Tom McDonaugh is the facilities manager for the Department of Embryology. He had previously been in the Navy, where his specialty was to take the worst-ranked ships and bring them to the top of the list, a talent that Meserve said could not have been better preparation for the job of managing the "creaky" old Embryology building with its "many decaying systems." Meserve further remarked on McDonaugh's exceptional work during the construction and operations of the new Singer building. "When the project was finished, a vice president of the construction company said of Tom that 'he got you a $40 million building for $30 million,'" Meserve said.

Planetary Heat Wave


Paul Butler
Image courtesy Paul Butler

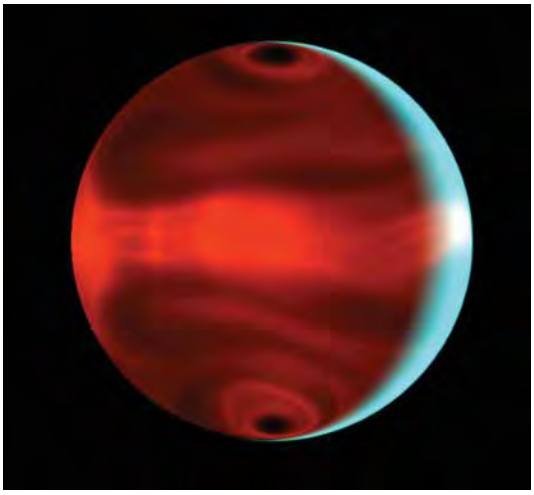
Here on Earth we worry about our planet's atmosphere warming by a few degrees on average over the next century, and even weather fronts bring temporary changes in temperature of no more than tens of degrees. Now a team of astronomers including DTM's Paul Butler have discovered an extrasolar planetary system where global warming is taken to a spectacular extreme: a 700°K rise in a few hours.

The planet, known as HD80606b, is a gas giant orbiting a star 200 light-years from Earth. Its extremely eccentric orbit around the star takes it from a relatively comfortable distance approximating the Earth's orbit to blazing hot regions much closer than Mercury is to our Sun. Infrared sensors aboard NASA's Spitzer Space Telescope measured the planet's temperature as it swooped close to the star, observing a planetary heat wave that rose from 980° to 2240°F (800° to 1500°K) in just six hours.

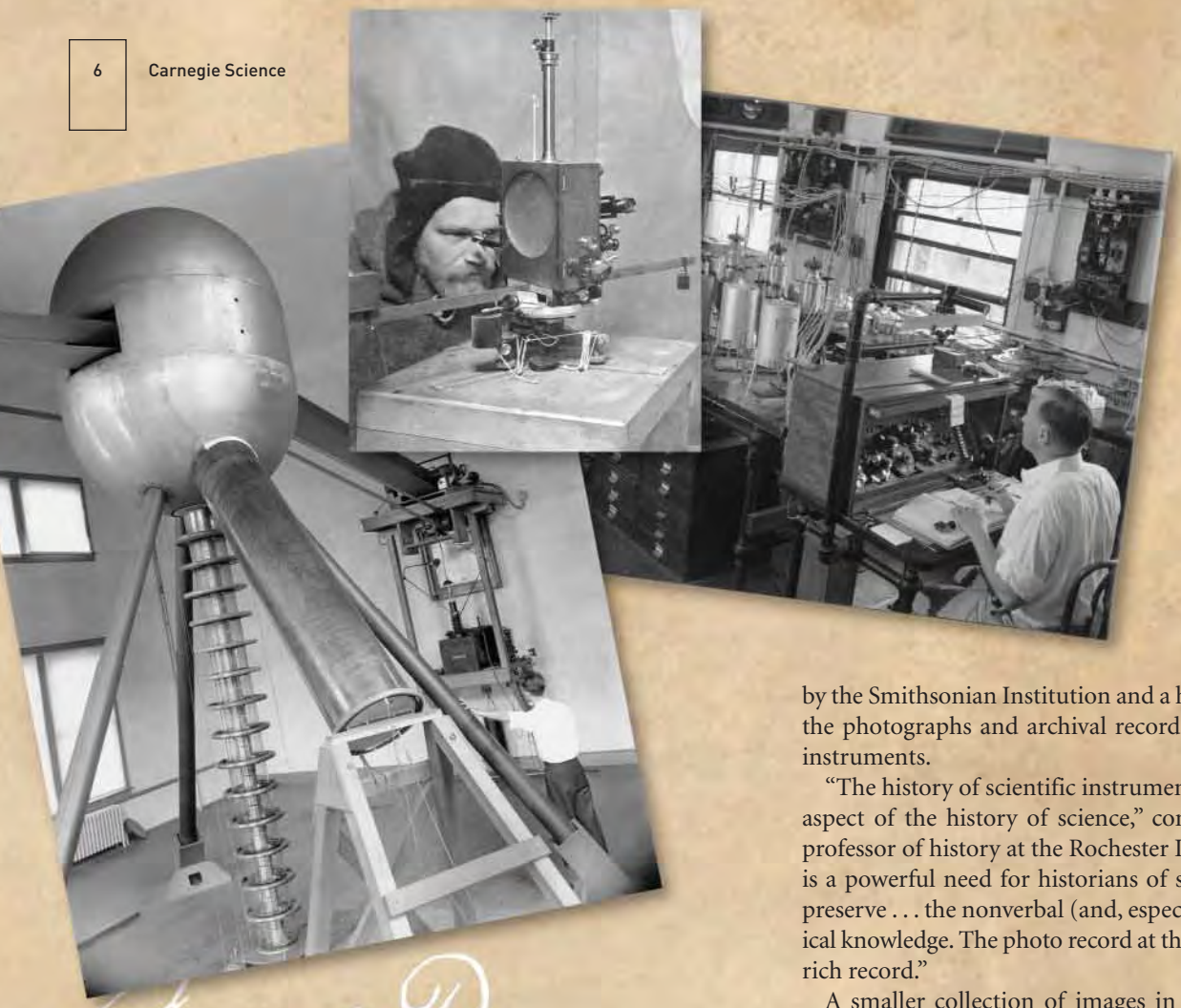
"Even after finding nearly 200 planets, the diversity and oddness of these new worlds continues to amaze and confound me," said Butler, who made the precision velocity measurements of the host star that allowed the planet's orbit to be calculated. Butler's work has uncovered about half of the known extrasolar planets.

The precision of the velocity measurements was crucial for this experiment. Observations from the infrared space telescope had to be centered on the time that the planet passed behind the star, known as the secondary eclipse. The disappearance of the planet during the secondary eclipse allowed the measurements to be calibrated and the planet's temperature to be determined.

HD80606b has an estimated mass of about four times that of Jupiter and completes its orbit in about 111 days. At its closest approach to the star it experiences radiation about 800 times stronger than when it is most distant. □


This computer-generated image depicts the severe weather patterns on the highly eccentric exoplanet HD80606b during the days after its closest approach to its parent star. The blue glow of the crescent is starlight that has been scattered and reflected by the planet. The starlight appears blue because the planet is a very efficient absorber of red light. The night side appears reddish orange as it glows with its own internal heat.
Image courtesy Greg Laughlin, University of California at Santa Cruz

This work is based on observations made with the Spitzer Space Telescope, which is operated by the Jet Propulsion Laboratory (JPL), California Institute of Technology (Caltech), under contract to NASA. Support for this work was provided by NASA.



(Left) DTM's million-volt Van de Graaff accelerator (1936) is located in what is now the David Greenewalt Building at Broad Branch Road.

(Center) This "universal magnetometer" was supplied by DTM for the Second Byrd Antarctic Expedition, 1933-1935. Observations were made at Little America station in a room cut in the ice.

(Right) These high-temperature quenching furnaces at the Geophysical Lab (ca. 1950) were used for experimental studies of rock-forming minerals.

Grant Preserves Historic Photos

BY SHAUN J. HARDY

Four thousand photographs documenting historic instruments and apparatus in geophysics, astrophysics, and atomic physics are held in the archives of the Department of Terrestrial Magnetism and the Geophysical Laboratory. The images and supporting documents provide an exceptional resource for the study of early 20th-century science. But until recently the effects of time and improper storage conditions had put the future of these historic images in jeopardy. Now, thanks to a grant from the Center for History of Physics at the American Institute of Physics, access to these materials will be safeguarded and enhanced for future generations of researchers.

The grant provides Carnegie with $9,400 to preserve and catalog the photos, which document virtually every significant type of instrument built by, or used at, DTM from 1904 through the 1950s. A dizzying variety of geomagnetic survey instruments employed during the department's formative years is represented in the collection, as are pathbreaking particle accelerators built in the 1920s and 1930s to probe the structure of the atom. With the exception of a few items held by the Smithsonian Institution and a handful of other organizations, the photographs and archival records are all that remains of these instruments.

"The history of scientific instruments has long been an important aspect of the history of science," commented Thomas D. Cornell, professor of history at the Rochester Institute of Technology. "There is a powerful need for historians of science to consult sources that preserve . . . the nonverbal (and, especially, visual) side of technological knowledge. The photo record at the DTM represents an especially rich record."

A smaller collection of images in the Geophysical Laboratory's archives complements the DTM photos and illustrates the development of high-pressure and high-temperature apparatus—one of the lab's hallmarks.

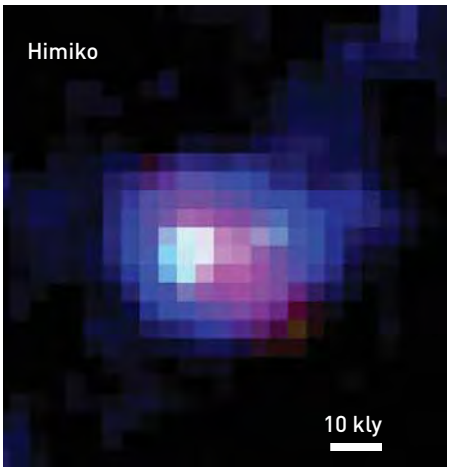
Joseph Neumann, an archivist from History Associates, Inc., began work on the photographs in January. Under the oversight of Broad Branch Road campus librarian Shaun Hardy, Neumann is rehousing original negatives, prints, and glass plates in acid-free sleeves and envelopes and transferring fragile albums to protective enclosures. John Strom, at Carnegie headquarters, is assisting the project by designing an image database that users will be able to search by instrument type, time period, and other criteria. A Web site with outstanding examples from the collection will be accessible via the *Carnegie Legacy* Web site (www.ciw.edu/legacy), the main gateway to the institution's historic archives. □

SHAUN HARDY is the librarian at the Broad Branch Road campus and serves both the Department of Terrestrial Magnetism and the Geophysical Laboratory.

Archivists Joseph Neumann and Emily Rupp are at work on the historic photo collections.

The AIP Center for History of Physics (www.aip.org/history/) works to preserve and make known the historical record of modern physics and allied sciences, including astronomy and geophysics. The center's program of Grants to Archives assists organizations in making accessible records, papers, and other primary sources for historical research.

Mysterious Space Blob Puzzles Astronomers



This image of the Himiko object is a composite and in false color. The thick horizontal bar at the lower right corner presents a distance of 10,000 light-years.

Image courtesy Masami Ouchi et al. and *The Astrophysical Journal*

Observatories fellow Masami Ouchi led the team that discovered the mysterious blob.

Image courtesy Masami Ouchi

A mysterious giant object is lurking out there at a time when the universe was only about 800 million years old. Observatories fellow Masami Ouchi led an international team that discovered it. It is called an extended Lyman-Alpha blob. These are huge bodies of gas that may be galactic precursors. This blob stretches a whopping 55,000 light-years, a length comparable to the radius of the Milky Way's disk and a record for that early time. The discovery was covered by media outlets around the world.

The team discovered the object using the Japanese Subaru telescope and named it Himiko after the legendary mysterious queen in ancient Japan. The object is puzzling. Even with superb data from five of the world's best telescopes, the scientists are not sure what it is. Because it is one of the most distant objects ever found, its faintness prevents the researchers from understanding its origins. It could be ionized gas powered by a supermassive black hole; a primordial galaxy with large gas accretion; a collision of two large young galaxies; superwind from intensive star formation; or a single giant galaxy with a large mass of about 40 billion Suns.

"I am very surprised by this discovery. I had never imagined that such a large object could exist at this early stage of the universe's history," remarked Ouchi. "According to the concordance model of Big Bang cosmology, small objects form first and then merge to produce larger systems. This blob has a size of typical present-day galaxies when the age of the universe was about 800 million years old, only 6% of the age of today's universe!"

Extended blobs discovered thus far have mostly been seen at a distance when the universe was 2 to 3 billion years old. No extended blobs have previously been found when the universe was younger. Himiko is located at a transition point in the evolution of the universe called the reionization epoch—it's as far back as we can see to date.

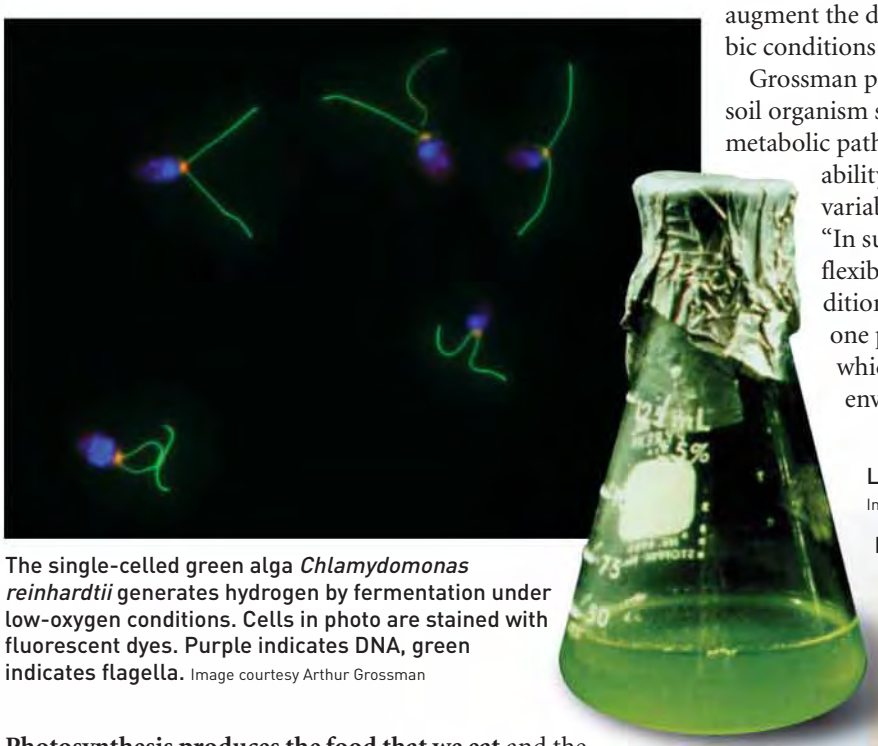
The reionization epoch was between about 200 million and 1 billion years after the Big Bang. During this period, neutral hydrogen began to form quasars, stars, and the first galaxies. Astronomers probe this era by searching for characteristic hydrogen signatures from the scattering of photons created by ionized gas clouds.

The team initially identified Himiko among 207 distant galaxy candidates seen at optical wavelengths in the constellation of Cetus using the Subaru telescope. They then made spectroscopic observations to measure the distance with the Keck/DEIMOS and Carnegie's Magellan/IMACS instrumentation. Himiko was an extraordinarily bright and large candidate for a distant galaxy. "We hesitated to spend our precious telescope time by taking spectra of this weird candidate. We never believed that this bright and large source was a real distant object. We thought it was a foreground interloper contaminating our galaxy sample," continued Ouchi. "But we tried anyway. Then, the spectra exhibited a characteristic hydrogen signature clearly indicating a remarkably large distance—12.9 billion light-years!"

Using infrared data from NASA's Spitzer Space Telescope and the United Kingdom Infrared Telescope, radio data from the VLA, and X-ray imaging from the XMM-Newton satellite, the team estimated its star-formation rate and stellar mass to see whether it contains an active nucleus powered by a supermassive black hole. Himiko is an order of magnitude larger than other objects known at a similar epoch, but the astronomers could not tell if the center is an active and growing black hole. The research is published in the May 10, 2009, issue of *The Astrophysical Journal.* □

The work was funded by the NASA through an award issued by JPL/Caltech, the Department of Energy, and the Carnegie Institution.

New Pathway for Hydrogen-Producing Algae



The single-celled green alga *Chlamydomonas reinhardtii* generates hydrogen by fermentation under low-oxygen conditions. Cells in photo are stained with fluorescent dyes. Purple indicates DNA, green indicates flagella. Image courtesy Arthur Grossman

Photosynthesis produces the food that we eat and the oxygen that we breathe—could it also help satisfy our future energy needs by producing clean-burning hydrogen? As an energy source to potentially replace fossil fuels, hydrogen would greatly reduce the emission of greenhouse gases. Proponents of algal-based hydrogen production point out that, unlike ethanol produced from crops, it would not compete with food production for agricultural land.

A single-celled green alga, *Chlamydomonas reinhardtii,* naturally produces small quantities of hydrogen when deprived of oxygen. Like yeast and other microbes, under anaerobic conditions this common inhabitant of soils generates its energy from fermentation. During fermentation, hydrogen is released though the action of an enzyme called hydrogenase, powered by electrons generated by either the breakdown of organic compounds or the splitting of water by photosynthesis. Normally, only a small fraction of the electrons goes into generating hydrogen. A major research goal has been to develop ways to increase this fraction, which would raise the potential yield of hydrogen.

In a new study, Plant Biology's Arthur Grossman and Florence Mus, with colleagues at the National Renewable Energy Laboratory and the Colorado School of Mines, examined metabolic processes in a mutant strain of *C. reinhardtii* that lacked an active hydrogenase enzyme. The researchers expected the cell's metabolism to compensate by increasing metabolite flow along other known fermentation pathways, such as those producing formate and ethanol as end products. Instead, the alga activated a different pathway.

"We actually didn't know that this particular pathway for fermentation metabolism existed in the alga until we generated the mutant," said Grossman. "This finding suggests that there is significant flexibility in the ways that soil-dwelling green algae can metabolize carbon under anaerobic conditions. By blocking and modifying some of these metabolic pathways, we may be able to augment the donation of electrons to hydrogenase under anaerobic conditions and produce elevated levels of hydrogen."

Grossman points out that it makes evolutionary sense that a soil organism such as *Chlamydomonas* would have a variety of metabolic pathways at its disposal. Oxygen levels, nutrient availability, and levels of metals and toxins can be extremely variable in soils, over both the short and the long term. "In such an environment these organisms must evolve flexible metabolic circuits," he said. "The variety of conditions to which the organisms are exposed might favor one pathway for energy metabolism over another, which would help the organism compete in the soil environment over evolutionary time." □

Laboratory culture of *Chlamydomonas* (left).
Image courtesy Arthur Grossman

Plant Biology's Florence Mus (below).
Image courtesy Arthur Grossman, Florence Mus

The project is being supported by the U.S. Department of Energy's GTL program within the Office of Biological and Environmental Research.

Asteroid Impact Helps Trace Meteorite Origins

Doug Rumble

Image courtesy Douglas Rumble

Andrew Steele

Image courtesy Andrew Steele

The car-sized asteroid that exploded above the Nubian Desert last October was small compared with the dinosaur-killing, civilization-ending objects that still orbit the Sun. But that didn't stop it from having a huge impact on scientists. This was the first instance of an asteroid spotted in space before falling to Earth. Researchers rushed to collect the resulting meteorite debris to take advantage of this first-ever opportunity to calibrate telescopic observations of a known asteroid with laboratory analyses of its fragments.

"Any number of meteorites have been observed as fireballs and smoking meteor trails as they come through the atmosphere," said Douglas Rumble of Carnegie's Geophysical Laboratory, a coauthor of the paper. "It's been happening for years. But to actually see this object before it gets to the Earth's atmosphere and then to follow it in—that's the unique thing."

The chemical composition of asteroids can be studied from Earth by analyzing the spectra of sunlight reflected from their surfaces. This provides enough information to divide asteroids into broad categories, but does not yield detailed information on their composition. On the other hand, meteorites recovered on Earth can be analyzed directly for chemical composition, but researchers generally have no direct information on what type of asteroid they came from.

The asteroid, known as 2008 TC_3, was first sighted October 6, 2008, by telescopes of the automated Catalina Sky Survey near Tucson, Arizona. Numerous observatories followed its trajectory and took spectrographic measurements before it disappeared into the Earth's shadow the following day. A recovery team led by Peter Jenniskens of the SETI Institute in California and Muawia Shaddad of the University of Khartoum then searched for meteorites along the projected approach path in northern Sudan. They recovered 47 fragments, one of which was selected for preliminary analysis by laboratories, including the Geophysical Laboratory.

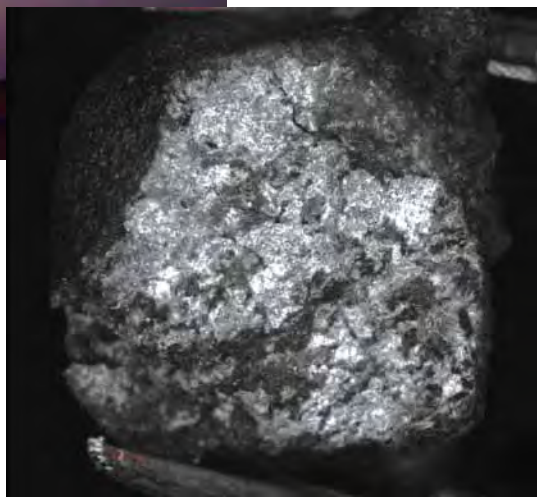
Carnegie's Andrew Steele studied the meteorite's carbon content, which showed signs that at some point in its past the meteorite had been subjected to very high temperatures. "Without a doubt, of all the meteorites that we've ever studied, the carbon in this one has been cooked to the greatest extent," said Steele. "Very cooked, graphitelike carbon is the main constituent of the carbon in this meteorite." Another form of carbon Steele found in the meteorite, nanodiamonds, may give clues as to whether the heating was caused by impacts on the parent asteroid or by some other process.

Oxygen isotopes in the meteorite give other information about its parent body. Each source of meteorites in the solar system, including planets such as Mars, has a distinctive signature of the three isotopes ^{16}O, ^{17}O, and ^{18}O. This signature can be recognized even when other variables, such as chemical composition or rock type, differ. "Oxygen isotopes represent the single most decisive measurement in determining the parental or family groupings of meteorites," said Rumble, who performed the analysis.

According to Rumble's analysis, 2008 TC_3 falls into a category of very rare meteorites called ureilites, all of which may have originally come from the same parent body. "Where that is, we don't know," said Rumble. But because astronomers took spectral measurements of 2008 TC_3 before it hit the Earth and can compare those measurements with the laboratory analyses, scientists will be better able to recognize ureilite asteroids in space. One known asteroid with a similar spectrum, the 2.6-kilometer-sized asteroid 1998 KU_2, has already been identified by researchers as a possible source for 2008 TC_3. □

These smoky meteorite trails were captured by a cell phone camera after asteroid 2008 TC_3 exploded over Sudan.

Image courtesy Mohamed Elhassan Abdelatif Mahir, Muawia H. Shaddad, Peter Jenniskens



This fragment of asteroid 2008 TC_3 provided scientists with the first-ever opportunity to calibrate telescopic observations of a known asteroid with laboratory analyses.

Image reprinted with permission from *Nature* vol. 458, pp. 485-488, March 26, 2009.

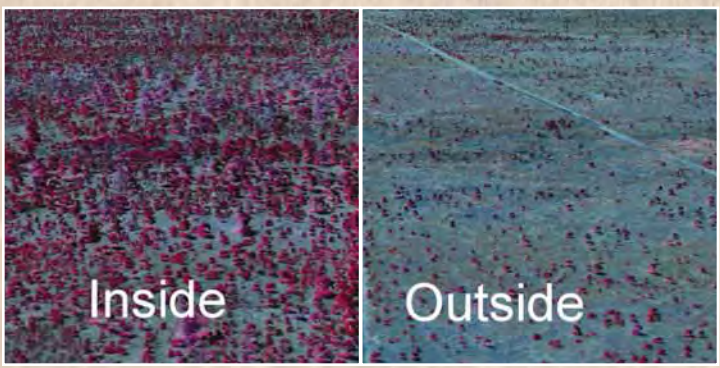
Rumble's work was funded by NASA Cosmochemistry grant NNX07AI48G. Steele was supported by NASA's Sample Return Laboratory Instruments and Data Analysis Program (SRLIDAP), NASA's Astrobiology Science and Technology for Exploring Planets (ASTEP) program, and the NASA Astrobiology Institute (NAI).

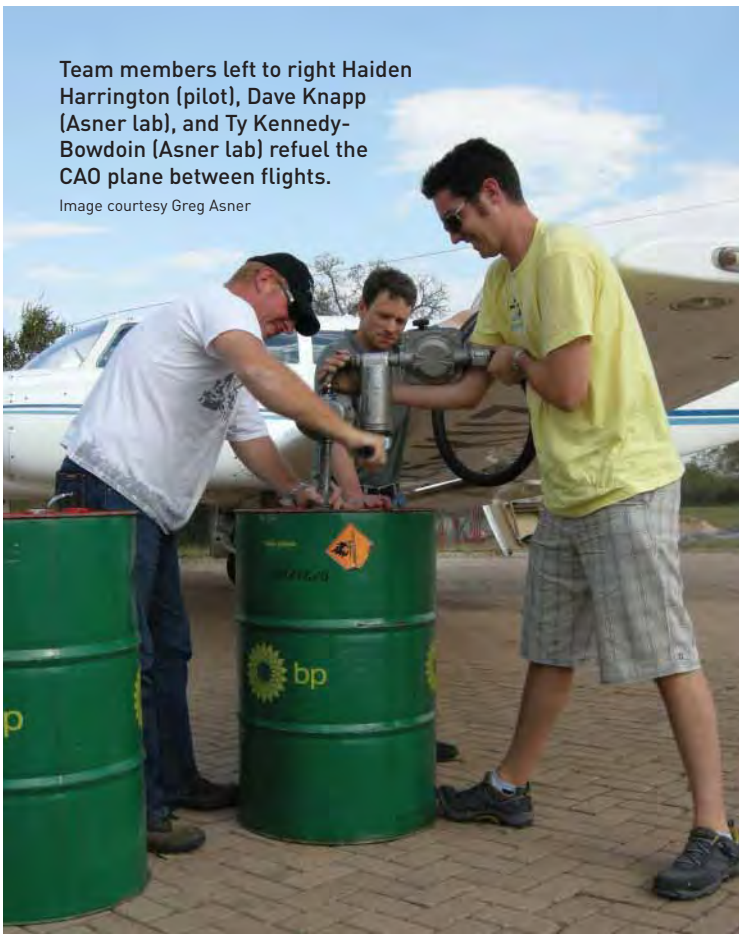
Airborne Ecologists Help Balance Delicate African Ecosystem

The African savanna is world famous for its wildlife, especially the iconic large herbivores such as elephants, zebras, and giraffes. But managing these ecosystems and balancing the interests of the large charismatic mammals with those of other species has been a perpetual challenge for park and game mangers. To help meet the challenge, a team led by Global Ecology's Greg Asner brought Carnegie's innovative airborne remote sensing technology to Africa to test its potential for monitoring the impact of management decisions on the savanna ecosystem. "These African savannas are extremely complex," said Asner. "On the ground they are notoriously hard to assess in terms of what management decisions, such as controlling fire and large herbivore populations, are doing to the entire ecosystem."

Large herbivores like this elephant have a huge impact on the savanna ecosystem, altering the 3-D structure of the vegetation.
Image courtesy Greg Asner

3-D images of African savanna vegetation in areas from which large herbivores have been excluded (left) and allowed access (right) give researchers a detailed picture of the ecological impact of the herbivores. The researchers can quantify not only the amount of vegetation change but also structural changes in the habitat.
Image courtesy Asner lab, Carnegie Institution





Team members left to right Haiden Harrington (pilot), Dave Knapp (Asner lab), and Ty Kennedy-Bowdoin (Asner lab) refuel the CAO plane between flights.
Image courtesy Greg Asner

CAO imagery taken from 7,000 feet renders the savanna landscape in exquisite detail.
Image courtesy Asner lab, Carnegie Institution

The aircraft-based Carnegie Airborne Observatory (CAO) combines a laser-based 3-D mapping system with high-fidelity imaging spectrometers to create detailed 3-D maps of vegetation over large areas at high resolution (approximately 50 centimeters). For this study, the research team surveyed the vegetation of about 4,000 acres of savanna in Kruger National Park, South Africa. Included in the survey were areas of different soil types and experimental plots where all herbivores larger than a rabbit had been excluded for periods up to 41 years, allowing researchers to discern the effects of both soils and large herbivores on savanna vegetation.

Not surprisingly, the CAO survey found less plant growth and more bare ground in areas where large herbivores had been allowed to graze, compared with areas from which they had been excluded. But the 3-D mapping capability of the CAO revealed differences in the structural complexity of vegetation between herbivore and herbivore-free areas. This has implications for the types of other species these areas are likely to support. And by quickly and precisely quantifying the vegetation differences from the air, the CAO team demonstrated the potential of the new technology as a management tool.

"We are really creating a new way to do ecology," said postdoc Shaun Levick. "What we're doing is collecting data for thousands of acres at extremely high 3-D resolution and getting clear answers for the first time as to what different management decisions do in the ecosystem."

Among the surprises in the study's results is that the impact of the large herbivores on vegetation cover is highest in areas where the soil has the highest concentration of nutrients, not in areas with poor-quality soil. The researchers interpret this to mean that herbivores concentrate their feeding in areas of high-quality forage, causing these areas to suffer a disproportionate impact. The team is preparing a similar study on the effects of fire on savanna vegetation in Kruger Park, according to Asner.

"There have been decades of excellent ground-based research on how different policies regarding fire and wildlife management play out," said Asner. "But the savanna ecosystem is spatially very complicated. With the CAO I think we're getting a picture of the large-scale impact of management decisions. That's what makes this series of studies unique." □

This research was funded by a grant from the Andrew W. Mellon Foundation. The Carnegie Airborne Observatory is supported by the W. M. Keck Foundation and William Hearst III.

Dog bones from the Dadiwan site, such as this skull from Phase 1 deposits, have a carbon isotopic signature indicating a diet high in millet. Because wild dogs are unlikely to have eaten such a diet, this finding suggests that the dogs were domesticated by the human inhabitants. It also suggests that the humans probably cultivated the millet for their own food.

Image courtesy Loukas Barton

Early Agriculture Left Traces in Animal Bones

Geophysical Laboratory's Seth Newsome used carbon and nitrogen isotopes in animal bones to trace the origins of agriculture in East Asia.

Image courtesy Seth Newsome

Unraveling the origins of agriculture around the globe has been a challenge for archaeologists: early crops are rarely preserved and can be difficult to distinguish from their wild ancestors. But a research team including Geophysical Lab (GL) postdoc Seth Newsome recently found evidence of early human experiments with grain cultivation in East Asia. The evidence comes from a surprising source—the bones of dogs and pigs.

The dog and pig bones came from an archaeological site in a region of northwest China considered to be a possible center of early agriculture. Chemical traces within the dog bones suggest a diet high in millet, a grain that wild dogs are unlikely to eat in large quantities, but that was a staple of early agricultural societies in northwest China. "If the dogs were consuming that much millet, their human masters were likely doing the same," said Newsome who performed the analyses.

The Neolithic site, known as Dadiwan, was first excavated by a Chinese team in the late 70s and early 80s, and again in 2006 by a team from the University of California, Davis, and Lanzhou University in China. From the excavations archaeologists have determined that humans occupied the site during two main phases, from 7,900 to 7,200 years ago (Phase 1) and from 6,500 to 4,900 years ago (Phase 2). Though some fossil remains of millet plants have been found in deposits from both phases, the fossils don't directly reveal how much millet contributed to the local diet.

To address this question, the researchers turned to a technique known as stable isotope analysis. Atoms of elements such as carbon come in different forms (isotopes) that are chemically similar but can be distinguished in the laboratory by minute differences in their mass. Certain kinds of plants known as C4 plants tend to concentrate heavier carbon isotopes as they grow, compared with other plants known as C3 plants. Animals with diets high in C4 plants also tend to concentrate heavier isotopes in their bones. As it turns out, millet is one of the few C4 plants that grow in arid northwest China, making the carbon isotopes in bone a good indicator of a millet-rich diet.

The researchers found that most of the dog bones from the Phase 1 deposits bore the isotopic signature of a high millet diet. This finding suggests that these dogs were domesticated and fed by humans who harvested millet. Bones of pigs from the site tell a slightly different story. In the Phase 1 deposits, the pig bones don't show signs of millet in the diet, so they were probably from wild pigs hunted and eaten by people. But pig bones from Phase 2 do have the isotopic signature of millet, so they were most likely domesticated by this time.

"Our results help fill in the picture of how agriculture arose in this part of the world," said Newsome. "There has been speculation that agriculture spread north from southern rice-farming areas, but the Phase 1 people were likely experimenting with agriculture by cultivating local grains. This simple system was later replaced by people in Phase 2, who had a much more developed agricultural system." □

Broomcorn millet (pictured) is a drought-tolerant grass still cultivated in northern China today. Because millet, like other C4 plants, concentrates heavy isotopes of carbon, a diet rich in millet produces a recognizable signature in animal tissues, such as bones.

Images courtesy Loukas Barton

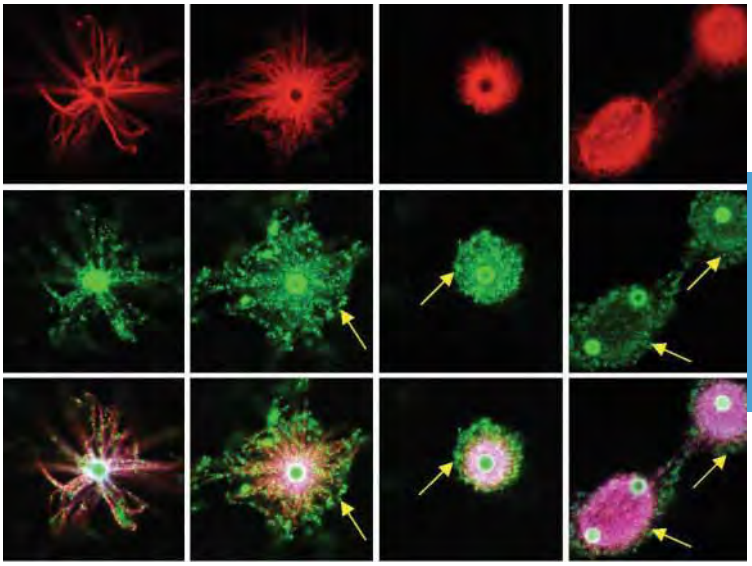
Deconstructing Cell Division

Yixian Zheng is a staff member at Embryology and a Howard Hughes Medical Institute Investigator.
Image courtesy Yixian Zheng

The last step of the cell cycle is the brief but spectacularly dynamic and complicated mitosis phase. It leads to the duplication of one mother cell into two daughter cells. In mitosis, the chromosomes condense and the nucleus breaks down. Fibrous structures called spindles form, which move the chromosomal material toward opposite ends of a cell and help partition other cell contents. If something goes wrong, diseases such as cancer can arise. Scientists have tried for years to unravel the process of spindle assembly. Now, researchers at the Department of Embryology have found that two proteins—dynein and Nudel—which are involved in other cell-division functions, are essential for regulating the assembly of the spindle matrix.

"To ensure proper cell division, the mother cell needs to separate its genetic materials, the chromosomes, equally, but also partition its cellular content properly into daughter cells," explained coauthor Yixian Zheng, staff member at Embryology and a Howard Hughes Medical Institute Investigator. "Cell division allows a fertilized egg to develop into multicellular organisms with different types of cells. It also replenishes adult tissues, such as skin and bones. Forming a spindle requires the assembly of a 'skeleton' from tubelike microtubules and the construction of a poorly defined scaffold called a spindle matrix."

In 2006, Zheng and colleagues discovered that a protein found in the nucleus during the interphase of the cell-division cycle, called lamin B, is a structural component of the spindle matrix. Based on this finding, she and colleagues have now isolated the spindle matrix. Interestingly, both dynein and Nudel are components of it. Nudel binds to lamin B and brings it to microtubules, where both Nudel and dynein then help the lamin B assemble into the spindle matrix.The lamin B-containing spindle matrix, in turn, works with microtubules to orchestrate spindle assembly and cell division.



This image shows an in vitro assay for the assembly of a lamin B-containing spindle matrix along microtubules during spindle assembly. Yellow arrows point to the lamin B network assembled along the microtubules.
Image courtesy Yixian Zheng

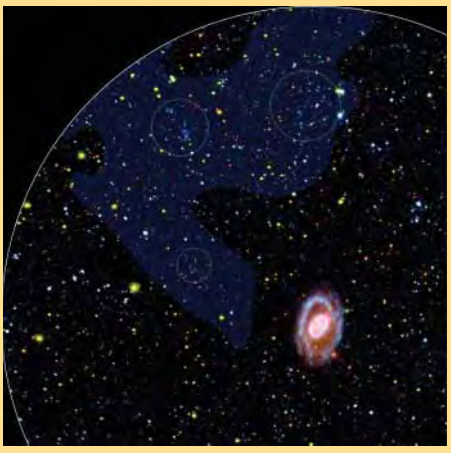
"Isolating the spindle matrix and identifying its components has also allowed us to show that the matrix contains not only factors important for spindle assembly, but also proteins essential for cell fate choices," said Zheng. "We believe that by understanding how the spindle matrix is assembled in mitosis, it will be possible to understand how, after mitosis, two daughters can chose to become the same or different cell types—a decision that cells need to make both during the development of an organism and during the maintenance of adult tissues." The research was published online in the February 8 issue of *Nature Cell Biology.* □

New Stars from Old Gas Surprise Astronomers

Mark Seibert Barry Madore

Evidence of star birth within a cloud of primordial gas has given astronomers a glimpse of a previously unknown mode of galaxy formation. The cloud, known as the Leo Ring, appears to lack the dark matter and heavy elements normally found in galaxies today. The unexpected discovery comes thanks to instruments aboard NASA's Galaxy Evolution Explorer (GALEX) spacecraft that are sensitive to the ultraviolet radiation emitted by newly formed stars.

The research team included Barry Madore and Mark Seibert of the Carnegie Observatories. "This demonstrates the tremendous power of observing the ultraviolet from space," said Seibert. "By discovering star formation in what is likely a new class of dwarf galaxy, the Galaxy Evolution Explorer observatory is certainly living up to its name."



An area of the Leo Ring gas cloud (blue overlay) shows blue clumps (in circles) that likely represent the ultraviolet emissions of dwarf galaxies in the process of formation.
Image courtesy NASA/JPL-Caltech/DSS

Continued on page 14 ▷

▽ *New Stars, continued from page 13*

The Leo Ring, discovered in 1983 by radio astronomers, is a cloud of hydrogen and helium gas orbiting two galaxies in the constellation Leo. The cloud is nearly invisible in optical wavelengths, and since its discovery astronomers had searched for stars within it without success. The launch of the GALEX spacecraft in 2003 with ultrasensitive UV detectors has made it possible to explore new wavelengths and detect ultraviolet emissions from the cloud's star-forming regions, which the astronomers interpret to be small galaxies known as dwarf galaxies.

Previous measurements of the masses and velocities of clumps of hydrogen within the Leo Ring suggest it lacks any significant dark matter component, an aspect that distinguishes these newly discovered sites of star formation from other known dwarf galaxies. Since in current cosmological models galaxies form in association with a massive "halo" of dark matter, this result suggests that the new galaxies formed through a distinct and not yet understood process.

Given the immense size of the Leo Ring, it is unlikely that the gas comprising it has been cycled through or extracted from the central galaxies. It is conceivable that this gas has been untouched since the beginning of the universe. If so, the newly formed dwarf galaxies could be almost pure hydrogen and helium and lack heavier elements ("metals" in astronomical terminology). The Leo Ring and its newly discovered ultraviolet dwarf galaxies would then provide astronomers with a nearby opportunity to see how galaxy formation probably proceeded in the very early universe.

The new type of dwarf galaxy may have been common in the early universe, when clouds of pristine gas would have been more abundant. The discovery opens a window on the process of star formation in primordial gases not yet enriched with heavy elements. □

The Galaxy Evolution Explorer mission is led by the California Institute of Technology, which is responsible for science operations and data analysis. NASA's Jet Propulsion Laboratory, Pasadena, California, manages the mission and built the science instrument. The mission was developed under NASA's Explorers Program, managed by the Goddard Space Flight Center, Greenbelt, Maryland. South Korea and France are the international partners in the mission.

Roy J. Britten, DTM Alumnus, Turns 90

BY JOHN GRULA

Roy J. Britten sits with other staff in the Terrestrial Magnetism library in the early 1960s. Front row (from left): Dean Cowie, Roy Britten, Brian McCarthy. Back row (from left): John Firor, B. F. Burke, Ellis Bolton, Scott Forbush.

Biophysicist Roy J. Britten, who was a Department of Terrestrial Magnetism (DTM) staff member from 1951 to 1971 and a staff member in a special subject area until 1989 while also a senior research associate at the California Institute of Technology, will turn 90 on October 1. While at DTM, Britten's groundbreaking work on DNA reassociation kinetics—a set of techniques that make it possible to measure the repetitive DNA sequences in a genome—led him to discover that such sequences are ubiquitous in the genomes of animals and plants, but are not found in simpler organisms such as bacteria. Some repetitive DNA sequences were later shown to influence gene regulation, and they often consist of transposons (mobile genetic elements) or transposon remnants that are able to cause changes in gene regulation. Britten's early recognition of the importance of gene regulation in macroevolutionary change and his longtime collaboration with Caltech developmental biologist Eric Davidson led to the founding of the important field within evolutionary biology now known as evo-devo.

Britten was one of a small number of young physicists who worked on the Manhattan Project during World War II. After the war, he attended Princeton University, where he obtained his Ph.D. in physics in 1951. As a graduate student he invented the use of astigmatic magnetic lenses to focus high-energy particles. Like a few other visionary physicists of the period such as Max Delbrück and Francis Crick, Britten migrated to the field of molecular biology. There he employed his physics background with others in DTM's biophysics group to conduct pioneering studies of DNA-DNA and DNA-RNA interactions and the large-scale sequence properties and evolution of animal, plant, and bacterial genomes. The group's studies of DNA sequence evolution in a wide range of organisms provided the basis for a new molecular approach to evolutionary classification and as a result revolutionized this field.

Britten and others in the biophysics group were also pioneers in discovering and perfecting a large number of new technologies and methods that made possible enormous strides in molecular biological research. These new advances were employed not just at DTM, but were successfully adopted by many other labs around the world. They included innovations such as the analysis of macromolecules using ultracentrifugation and the development of powerful methods for the study of repetitive DNA.

These techniques were used by Britten and coworkers to identify and characterize different classes of repetitive DNA in the genomes of a wide variety of higher organisms. The various classes of DNA repeats they discovered ranged from short "satellite" sequences present on a single chromosome in as many as 1 million adjacent copies to longer repetitive sequences that are interspersed among multiple chromosomes in several hundred copies or less. His study of repetitive sequences inspired Britten and Eric Davidson to incorporate them in a detailed model for gene regulation in higher organisms, and in 1969 they published their model in what became a highly influential paper in the journal *Science*.

Roy Britten was elected to the National Academy of Sciences in 1972. He continues his research to this very day, and is currently working on a paper, "Contrast in frequency of transposable element related sequences in chimpanzee and human genomes," as well as on several other papers. □

JOHN GRULA is the astronomy librarian at The Carnegie Observatories in Pasadena. During 1978-1981 he was a postdoctoral fellow in Roy Britten's group at Caltech's Kerckhoff Marine Lab.

InBrief

❶ Carnegie president Richard Meserve is shown here in Red Square. Saint Basil's Cathedral is in the background.

❷ Alan Cutler
Image courtesy Mulyono Kertajaya

❸ Steve Farber

Trustees and Administration

❶ Carnegie president **Richard A. Meserve** opened the 3rd DCBiotech Mentoring Dissemination Conference on Feb. 5, sponsored by CASE. He traveled to the Las Campanas Observatory, Chile, Feb. 9-13 and May 24-29 with guests. He participated in the ASEAN Regional Roundtable on nuclear safety, sponsored by the Singapore Ministry of Foreign Affairs on Mar. 1-2, and in the panel "Intellectual Property Rights and Global Climate Change" at the Sixth Annual Intellectual Property Law Seminar at Howard U. School of Law on Mar. 6. Meserve opened a symposium on nuclear policy organized by the Atomic Heritage Foundation held at headquarters on Mar. 14. He spoke at a nuclear nonproliferation conference in Moscow sponsored by the Russian Academy of Sciences and the Nuclear Threat Initiative on Mar. 18-20, and chaired a meeting of the National Academies' Nuclear and Radiation Studies Board (NRSB) on Mar. 30-31. He was cochair of the planning committee for a study by the American Academy of Arts and Sciences on the Global Nuclear Future on Apr. 6 in Washington, DC, and chaired a meeting of the IAEA's International Nuclear Safety Group in Vienna on Apr. 7-9. He spoke on energy policy at a convocation of the National Academy of Engineering and the American Association of Engineering Societies on Apr. 20. On Apr. 25 he spoke on science advising at the annual meeting of the American Philosophical Society in a session honoring former trustee William T. Golden in Philadelphia. Meserve participated in a visiting committee at the Harvard School of Engineering and Applied Sciences Apr. 27-28. He spoke at an event honoring former trustee Robert C. Seamans, Jr., at MIT June 10, and spoke at a conference sponsored by the Indiana U. School of Public and Environmental Affairs on energy policy in Washington, DC, June 11. Meserve was a representative of the National Academy of Engineering and gave a paper on energy policy in Moscow June 17-18, in celebration of the 50th anniversary of cooperation with the Russian Academy of Sciences. He gave a presentation on international nuclear safety at the Nuclear Plant Safety Summer Course at MIT on June 24.

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❷ **Alan Cutler** gave an invited talk on the role of Nicolaus Steno in the discovery of geologic time at the conference "Il tempo profondo da Stenone a Darwin" (Deep Time from Steno to Darwin), hosted by Museo di Storia Naturale, Università di Firenze, in Florence, Italy, on Feb. 6.

Symposium organizer Don Fox (left) talks with Yixian Zheng (center) and speaker Jeff Brodsky.

Each year Carnegie postdoctoral fellows organize a meeting. This year it was "Cellular Strategies for Stress Response," Embryology's 28th Annual Minisymposium, on Apr. 16-17. How cells, tissues, and organisms respond to stress is of critical importance to their survival, and adaptability and stress responses play key roles in managing tissue damage over time. The seven speakers described their work using a variety of model systems to study how organisms and cells respond to changes in salt or oxygen in the environment, how stress response pathways such as the process of autophagy are used during normal development, and how stress responses interact with evolutionary pressures. This year's symposium was organized by postdoctoral fellows **Donald Fox**, **Rebecca Frederick**, and **James Walters**. □

Embryology

Allan Spradling attended the 50th annual *Drosophila* conference in Chicago Mar. 4-8, and participated in the NSF Workshop "Tools for 21st Century Biology." He also presented lectures at U. Toronto and at the Hospital for Sick Children and was a session chair at the Keystone Symposium "Stem Cell Niche Interactions."

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Joseph Gall was the Fourth Annual Margot and Robert Haselkorn Lecturer in the Dept. of Molecular Genetics and Cell Biology at U. Chicago Apr. 19-23.

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Visiting scientist **Svetlana Deryusheva** and graduate student **Zehra Nizami** presented a poster titled "Are Splicing snRNAs Modified in the Cajal Body?" at the 50th annual *Drosophila* conference in Chicago Mar. 4-8.

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Doug Koshland gave invited seminars at UC-Davis and Haverford College. Lab postdoc **Frederick Tan** has been awarded a Jane Coffin Childs Memorial Fund postdoctoral fellowship, which will support his work for three years.

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Yixian Zheng lectured at Sloan Kettering, U. of Nevada Medical Center, and at the Eppley Institute.

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CDAC Winter Workshop Held at APS, Argonne National Laboratory

The Carnegie/DOE Alliance Center (CDAC) winter workshop took place on Feb. 27-28 at the Advanced Photon Source, Argonne National Laboratory. Forty-two graduate students and postdoctoral associates (including 28 graduate students from CDAC academic partner groups) attended a series of six tutorials given by CDAC academic partners and three lectures by scientists from NNSA laboratories. The lectures were on a broad range of topics relevant to high pressure–high-temperature materials research. The workshop also featured short presentations provided by nine CDAC graduate students on their dissertation research and a poster session on the evening of Feb. 27, which included 32 posters prepared by students and postdoctoral associates at the workshop. □

Participants at the Carnegie/DOE Alliance Center (CDAC) winter workshop last Feb.

(Above) Fogel and Newsome in Argentina (Below) Students learn how to prepare samples.
Images courtesy Marilyn Fogel

Marilyn Fogel and Seth Newsome

taught a stable isotope ecology course to young Latin American researchers in Argentina. An excerpt from Marilyn Fogel's report follows:

"Seth Newsome and Marilyn Fogel completed teaching a one-week intensive course in stable isotope ecology for 26 graduate students from all over Argentina and Uruguay at the National Universidad de la Plata in La Plata, Argentina, Mar. 1-6. The two were hosted by former GL student and visiting investigator Luciana Ricciardelli, who visited the lab last winter. Luciana studies the diets and migration patterns of cetaceans from the southern Argentina coast using stable isotope patterns.

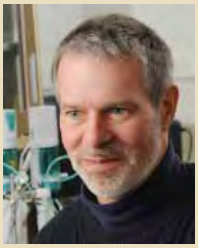
"The course included basic and advanced lectures on the fundamentals, principles, and applications of stable isotopes to ecological research. Students attending the course were from ecology, biology, earth sciences, and anthropology backgrounds. Many of them were already using stable isotopes in their research, yet did not have the experience in learning about the field from a professor or structured class.

"The class was presented in English with extensive readings from current and classic scientific literature. The students also were exposed to a mock field trip complete with sample collection and processing. Seth and I found that we knew a lot! It was a real pleasure to be able to share our knowledge with so many eager and bright students.

"The culmination of the class included 10-minute presentations by each student on the possible role of isotopes in their research...." □

For more see http://fogel.gl.ciw.edu/index.php?&menuid=15#178/

❹ Wesley T. Huntress, Jr.



❺ Bob Hazen

❻ Guayana Paez-Acosta

❼ Jack Silverman

❸ **Steve Farber** presented a lecture at the Mayo Clinic titled "Visualizing Intestinal Lipid Metabolism in Live Animals: Studies with Guts."

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Postdoctoral fellow **Shreyas Jadhav** joined the Bortvin lab in Apr.

Geophysical Laboratory

Director **Russell Hemley** presented talks at the Carnegie/DOE Alliance Center on Year Six Review in Argonne, IL, on Feb. 26; the invited talks "High-Pressure Geoscience: New Tools and Expanding Outreach" at the Workshop on Long Range Plans for High Pressure Earth Sciences in Tempe, AZ, Mar. 2-4, and "New Chemistry of Materials under Pressure," at UC-Berkeley, Apr. 14. On Apr. 21-28 he gave an invited talk, "Pressure, Materials, and Energy," at the Erskine Williamson Day Symposium in Edinburgh, UK.

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❹ Former GL director **Wesley T. Huntress, Jr.**, has been appointed by the National Research Council to the Steering Committee of the Solar System Exploration Decadal Survey. The cochairs are Steve Squyres of Cornell and Larry Soderblom of the USGS Flagstaff. This group will gather input from the planetary science community to define the current state of knowledge, the most important scientific questions, and develop the science and flight investigation strategy for NASA's Solar System Exploration program for the years 2011-2020. The two-year effort begins this June.

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Doug Rumble attended the Lunar and Planetary Science Conference in Houston, where he jointly presented a paper on the oxygen isotope composition of newly discovered Martian meteorites. Michael Zolensky (JSC) and Rumble gave an informal talk on the meteorites recovered by Peter Jenniskens (SETI) during a field trip to Sudan in Dec. to track the asteroid after it exploded in the upper atmosphere. The asteroid was the first to be observed in space prior to collision with Earth. Its fragments were subsequently collected for analysis.

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Ho-kwang (Dave) Mao presented a plenary talk, "Energy Frontier Research in Extreme Environments," at the Study of Matter at Extreme Conditions 2009 Meeting, Miami, Western Caribbean, Mar. 28-Apr. 2.

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❺ **Bob Hazen**, continuing his tenure as Sigma Xi Distinguished Lecturer at George Mason U., lectured on topics related to life's origins and evolution at the College of Charleston, SC; The Citadel, SC; the Army Research laboratory, MD; Princeton U.; the Smithsonian Institution; U. Tennessee-Martin; East Tennessee State U.; Fairfield U., CT; and Cornell U. He was also the 2009 Charter Lecturer at U. Georgia.

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On Feb. 28 **Bjørn Mysen** joined a steering committee meeting for the Institute for Study of the Earth's Interior, Okayama U., Japan, where he gave an invited lecture on Feb. 24 titled "COH Volatiles in Silicate Melts—Role of C-Bearing Volatiles during Chemical and Isotopic Evolution of the Silicate Earth."

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Henderson James Cleaves III was awarded an NRC/NAI Senior Postdoctoral Fellowship for 2009-2010.

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Muhetaer Aihaiti presented the talk "High-Pressure X-ray Diffraction and Raman Scattering Studies of $Pb(Mg_{1/3}Nb_{2/3})O_3$-$xPbTiO_3$" at the American Physical Society during the Mar. 16 meeting in Pittsburgh.

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Anat Shahar presented a talk, "Experimental Evidence for Isotope Fractionation during Planetary Differentiation," at the Lunar and Planetary Science Conference in Mar.

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Arrivals: Reto Giere (U. Freiburg, Germany) visited in Mar. to work with Doug Rumble on metamorphic rocks from Campolungo in the Swiss Alps. **Shuhei Ono** (MIT) visited in Apr. to analyze sulfur isotopes in Precambrian rocks. Postdoctoral fellow at McGill U. **Emilie Thomassot** visited in Dec. and analyzed for oxygen isotopes in samples of the very ancient rocks from Nuvvuagittuq, Superior Province, Canada. The samples are the same as those shown by Jonathan O'Neil (McGill)

❾ Ken Caldeira

❽ Kenny Schneider

❿ Eve-Lyn Hinckley

⓫ Jenny Greene

and DTM's Rick Carlson to be as old as 4.3 billion years old.

Global Ecology

On Feb. 14 **Chris Field** spoke at a symposium titled "What Is New and Surprising since the IPCC Fourth Assessment?" during the annual meeting of the American Association for the Advancement of Science in Chicago. He attended IPCC meetings in Copenhagen Mar. 9-13 and in Oslo Mar. 20-25.

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On Mar. 18 **Jason Funk** returned briefly to defend his Ph.D. thesis on the subject, "Carbon Farming in New Zealand: An Interdisciplinary Assessment of Indigenous Reforestation as a Land-use System."

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❻ On Jan. 12 **Greg Asner** spoke on the loss and recovery of the world's humid tropical forests at a Smithsonian Institution symposium. **Guayana Paez-Acosta** traveled to Peru and Bolivia in Feb. to meet with key institutions with whom we are working to use our CLASlite system for forest monitoring.

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❼❽ **Jack Silverman** and **Kenny Schneider** in the Caldeira lab continued the study of marine ecosystems on Australia's Great Barrier Reef. From Feb. 6-26 they were at One Tree Island, which is made entirely of coral rubble, and were accompanied by former lab technician **Chris Andreassi**.

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❾ On Feb. 9 **Ken Caldeira** acted as a member of the delegation of the Intergovernmental Oceanographic Commission to the International Maritime Organization's (IMO) meeting in London on the regulation of ocean fertilization. The IMO is the governing body for the London Convention and London Protocol (international agreements designed to limit ocean dumping). On Feb. 26 he testified in Washington before a congressional committee on HR 860 on the need to address carbon dioxide emissions that are affecting coral reefs, overfishing, and pollution. On Mar. 2 Caldeira participated in an NSF roundtable discussion titled "The Challenges of Climate Change," sponsored by the California Academy of Sciences and the Exploratorium in San Francisco. Excerpts from the discussion were published in the June issue of *Discover* magazine. On Mar. 19 *Rolling Stone* magazine ranked Caldeira as number 36 among 100 "Agents of Change." The list includes "artists and leaders, policymakers, writers, thinkers, scientists and provocateurs who are fighting every day to show us what is possible."

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❿ **Arrivals:** In Mar. **Eve-Lyn Hinckley** joined the Field lab as a postdoc. Computer technician **Aravindh Balaji** joined the Asner lab Jan. 5. **Chris Anderson** was hired Apr. 13 as a lab technician in that lab, and **Carey Lamprecht** went from part time to full time. On Apr. 9 four interns/lab technicians were hired for the Hawaii Asner lab: **Iwikauikaua Joaquin**, **Reid Loo**, **Albert Cortes, Jr.**, and **Mokila Joaquin**. Postdoctoral associate **Ho-Jeong Shin**, from South Korea, joined the Caldeira lab Mar. 13.

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Departures: Christina Contreras left the Asner lab Feb. 2 to work in private industry. Technician **Steven Ambagis** departed Mar. 6, and on Apr. 27 **Jessica Hunt** left for a job in private industry.

Observatories

⓫ Carnegie-Princeton/Hubble Fellow **Jenny Greene** was awarded the 2009 Bok Prize by Harvard U. for outstanding research based on her Ph.D. thesis.

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Wendy Freedman gave a talk on dark energy at the Categorically Not! event on Feb. 1 in Santa Monica. As NSF Distinguished Speaker, Freedman gave a talk on "Measurements of the Expanding Universe" on Mar. 9 at NSF in Arlington, VA. She was a member of the External Review Panel for the Dept. of Astronomy at U. Texas-Austin Mar. 29-Apr. 2.

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Staff Astronomer Emeritus **Allan Sandage** was inducted into the Royal Society as a Foreign Member in the Observatories library on Apr. 9. Director Wendy Freedman welcomed guests, which included Royal Society members Donald Lynden-Bell and Wallace Sargent. Lynden-Bell and his wife, Ruth, traveled from Cambridge for the occasion, bringing greetings from Lord Rees, president of the Royal Society. Sandage signed his name to a sheet of parchment for the society's Charter Book. He then addressed the guests and staff, giving career advice to the many postdoctoral fellows. A reception followed. Allan and Mary Sandage were further honored at a lunch at The Athenaeum offered by the Royal Society. □

Observatories director Wendy Freedman (left) and the Royal Society's Donald Lynden-Bell (middle) celebrate Allan Sandage's induction into the prestigious group.
Image courtesy Silvia Hutchinson

⓬ Observatories' Pat McCarthy

⓭ Spitzer fellow Jane Rigby

⓮ Plant Biology's Winslow Briggs (right) celebrates Wolf Frommer's appointment as director at the department party.
Image courtesy Mary Smith

⓬ Staff astronomer and Giant Magellan Telescope (GMTO Corporation) director **Patrick McCarthy** helped organize a workshop in Munich on science with ALMA and extremely large telescopes, where he spoke on "Science with the Giant Magellan Telescope." McCarthy has been acting director of the GMTO since Oct. and was recently elected permanent director of the corporation.
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Staff astronomer **Luis Ho** gave invited lectures and hosted several miniworkshops at Seoul National U., Yonsei U., and the Korea Astronomy and Space Science Institute. He gave colloquia at the Yunnan Observatory in Kunming, China, at UC-Santa Cruz, and at Toronto U., Canada.
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Carnegie Fellow **Masami Ouchi** gave an invited talk at the Japan-Princeton-Taiwan HSC Workshop in Japan, Jan. 17-20, and at the conference "Reionization at Ringberg: The Cosmic Evolution of Helium and Hydrogen," in the Ringberg Castle, Germany, Mar. 24-27. He also visited Subaru Observatory in HI.
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Postdoctoral associate **Chris Burns** gave an invited talk at Fermilab about the Carnegie Supernova Project.
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⓭ Spitzer Fellow **Jane Rigby** gave invited talks at the Hertzberg Institute of Astrophysics at U. Washington in Feb. and at U. Michigan in Mar. She also participated in the Feb. 19 science team meeting for the NuStar mission, a NASA small explorer set to launch in 2011. Rigby also gave an introductory lecture to visiting Claremont College students about black holes and active galactic nuclei.
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On Mar. 31 Spitzer Fellow **Jane Rigby** and NSF Fellow Karín Menéndez-Delmestre facilitated a discussion with visiting students from Claremont College about careers in astronomy and physics.
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The winter and early-spring months saw a steady succession of visitors. **Zheng Zheng**, Bahcall Fellow at the Institute for Advanced Studies, visited during Jan. and presented a colloquium on "Galaxy Evolution from Galaxy Clustering." **Julianne Dalcanton**, professor at U. Washington, visited in Feb. and gave a colloquium on "Stellar Populations with HST: Probing the History of Galaxies." **Thomas J. Cox**, Keck Fellow at the CfA, visited during Mar./Apr. and presented his work on the formation history of elliptical galaxies. **Karl Gebhardt**, professor at U. Texas-Austin, visited during Apr. and presented a colloquium on "HETDEX Pilot Survey Results: z=2 Lyman-alpha Emitters and the Instrument VIRUSB."
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Postdoctoral associate **Violet Mager** attended the AAS meeting in Long Beach, CA, Jan. 5-8, and the GALEX group meeting in Aspen, CO, Mar. 9-13.
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On Jan. 5 **Wendy Freedman**, **Pat McCarthy**, **Steve Shectman**, **Matt Johns**, and **Luis Ho** hosted a group of scientists visiting the Observatories from China. Then, on Jan. 12, the GMT hosted visitors from the Indian Institute of Astrophysics.
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Sean Solomon of Terrestrial Magnetism, **George Preston**, **Jane Rigby**, and **Josh Simon** of the Observatories presented lectures during the seventh season of the Carnegie Astronomy Lecture Series at The Huntington Library, Art Collections, and Botanical Gardens in San Marino, CA.

Plant Biology

⓮ A reception celebrating **Wolf Frommer**'s appointment as the new department head was held Mar. 18. Winslow Briggs, former director, shared some departmental history, while Frommer talked about his vision for the department.
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Winslow Briggs was the keynote speaker at the Keystone Conference on Plant Sensing, Response, and Adaptation to the Environment in Big Sky, MT, in Jan. He also presented a lecture titled "The Wide, Wide World of the Phototropin LOV Domains" at UC-Berkeley in Feb.
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Zhiyong Wang presented a lecture, "The Brassinosteroid Signaling Pathway: All Connected," at UC-Riverside in Jan. In Mar. he presented a lecture at the North Carolina Biotechnology Center, Durham.
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Matt Evans and **Allison Phillips,** a fellow in Evans's laboratory, attended the 51st Annual Maize Genetics Conference in St. Charles, IL, in Mar.
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Eva Huala attended the Plant and Animal Genome XVII Conference in San Diego in Jan. and participated in the text mining workshop. She also attended the Cold Spring Harbor Laboratory Plant Genomes meeting in Cold Spring Harbor, NY, in Mar., as did **Debbie Alexander**, **Peifen Zhang**, and **Philippe Lamesch**, members of the TAIR laboratory. Alexander and Zhang presented seminars there.
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Zhiping Deng, a postdoctoral researcher in the Wang lab, received a travel award to attend the Keystone Symposium on Plant Sensing, Response, and Adaptation to the Environment in Jan.
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Arrivals: The Frommer lab welcomed two visiting researchers: **William Mousell** (Penn. State U.) arrived on Mar. 1 for a month and **Friederike Ladwig** (U. Tübingen, Germany) arrived Apr. 7. The Grossman lab welcomed visiting investigator **Duan Delin** from the Chinese Academy of Sciences on Jan. 30. Two postdoctoral research associates also joined the lab: **Wenqiang Yang** (Chinese Academy of Sciences) on Feb. 4 and **David Dewez** (UC-Berkeley) on Mar. 1. The Ehrhardt lab welcomed Stanford student **Kelli Davis** on Mar. 30. Visiting fellow **Ken-Ichiro Hibara** (Laboratory of Plant Breeding and Genetics, U. Tokyo) joined the Barton lab on Apr. 13, and **Emma Sedivy** (Stanford U.) joined Devaki Bhaya's lab on Jan. 26 as a laboratory assistant. High school student **Vishu Bakshi** started volunteering in Sue Rhee's lab on Mar. 19.
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Departures: Frommer lab visiting student **Mara Hartung** returned to U. Tübingen, Germany, on Jan. 30. Postdoctoral associate **Do Young Kim** left the lab on Apr. 30 to be a postdoctoral research associate at U. Wisconsin-Madison. Postdoctoral associate **Yi Shin Su** left the Briggs lab to return to China on Mar. 15. Postdoctoral associates **Shaun Bailey** and **Jeffrey Moseley** left the Grossman lab on Mar. 15 and Mar. 20, respectively, to join the staff of Aurora Biofuels in Alameda, CA.

Terrestrial Magnetism

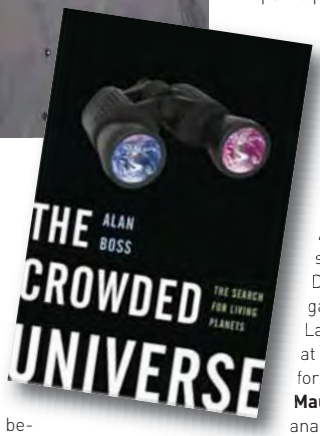
Sean Solomon attended meetings of the Advisory Boards for the Max Planck Institute for Chemistry in Feb. and the Earth Institute of Columbia U. in Mar. Also in Mar. he organized two special sessions on the MESSENGER flybys of Mercury at the 40th Lunar and Planetary Science Conference, and he gave an invited overview of mission results at the 39th Brown-Vernadsky Microsymposium on Volcanism on the Moon and Mercury; both meetings were in The Woodlands,

⓰ Rick Carlson

⓱ Alycia Weinberger

⓲ Jessica Warren

⓳ Wen-che Yu



⓯ Alan Boss and his book

TX. In Apr. he accepted, on behalf of the MESSENGER mission team, the Nelson P. Jackson Aerospace Award from the National Space Club in Washington, DC. He also spoke about MESSENGER as part of the Carnegie astronomy lecture series of the Carnegie Observatories and in a physics and astronomy seminar at James Madison U. In May he chaired a meeting of the MESSENGER science team held at Brown U. Science team member **Larry Nittler** also attended.

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Vera Rubin attended the annual meeting of the American Association of Physics Teachers in Feb. in Chicago, and delivered the Richtmyer Memorial Award Lecture. In Apr. she participated in Family Astronomy Day at the Smithsonian National Air and Space Museum by discussing dark matter and playing science games with children. She also delivered a formal lecture at the museum, titled "What Is the Universe?" and discussed the same topic at a Smithsonian Resident Associate Program, "A Cosmic Journey through Space and Time," held at the National Academy of Sciences. Also in Apr. Rubin chaired the search committee for a new director of the Lowell Observatory in Flagstaff, AZ.

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⓯ In Jan. **Alan Boss** was elected chair of the astronomy section of the American Association for the Advancement of Science (AAAS). He gave the overview talk in Feb. for the symposium "Origin and Evolution of Planets" at the AAAS annual meeting in Chicago. Boss outlined the publication plans for NASA's Kepler Space Telescope at the Kepler science team meeting in Cocoa Beach, FL, in Mar., and watched the night launch of Kepler from Cape Canaveral Air Force Station. That same month, Boss gave public lectures about his new book, *The Crowded Universe: The Search for Living Planets*, at the Commonwealth Club, San Francisco, the Berkeley City Club, Town Hall, Seattle, and Microsoft Headquarters in Redmond, WA. In Apr. Boss chaired a session at the Missions for Exoplanets meeting in Pasadena and spoke about his book at Caltech and at the San Diego Science Festival. In May he participated in the Astro 2010 decadal survey Jamboree in Irvine, CA. Boss also delivered three dozen radio and television interviews about his book during this time.

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⓰ In Apr. **Rick Carlson** was elected a 2009 fellow of the American Academy of Arts and Sciences. In Mar. he served on the NSF Continental Dynamics Review Panel and gave a colloquium on the High Lava Plains Seismic Experiment at Johns Hopkins U. He hosted former postdoctoral fellow **Maud Boyet** in Apr. to continue analyzing the Nd isotopic composition of ancient rocks in the lunar crust. In May Carlson conducted fieldwork with colleagues from MIT and USGS at the Newberry Volcano and Mount Shasta and assisted with data recovery from the seismic array across eastern OR.

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In Mar. **Paul Silver** spoke on remote triggering of fault strength changes on the San Andreas Fault at Purdue U. He participated in fieldwork in Apr. on the Olympic Peninsula to prepare for an active-source study of an upcoming episodic tremor and slip event and delivered a BBR neighborhood lecture on "The Quest for Earthquake Prediction." Also in Mar. and Apr. Silver hosted former postdoctoral fellows **Maureen Long** and **Guilhem Barruol** to continue collaborations on subduction zone anisotropy and dynamics and crustal anisotropy, respectively.

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In Mar. and Apr. **Larry Nittler** gave colloquia on presolar stardust at U. Rochester, Michigan State U., and U. Maryland-College Park.

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⓱ **Alycia Weinberger** participated in the Giant Magellan Telescope Science Advisory Council meeting at the Carnegie Observatories in Feb. She gave colloquia on nearby circumstellar disks in Mar. and Apr. at U. Colorado and Ohio State U.

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John Chambers spoke about models for protoplanetary disks at the 40th American Astronomical Society Division on Dynamical Astronomy annual meeting held in Virginia Beach in May.

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Scott Sheppard gave an invited lecture on detecting small bodies in our Solar System at U. Virginia in Feb.

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In Feb. postdoctoral fellow **Nick Schmerr** gave an invited talk on upper mantle discontinuity topography beneath South America at the 5th Stagnant Slab Symposium in Kyoto, Japan.

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⓲ Postdoctoral fellow **Jessica Warren** gave talks on midocean ridge chemical heterogeneity at Stanford U. and at the Lamont-Doherty Earth Observatory of Columbia U. in Mar. and Apr., respectively. Also in Mar. Warren attended the Marine Geoscience Leadership Symposium in Washington, DC.

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⓳ In Mar. and Apr. postdoctoral fellow **Wen-che Yu** gave colloquia on the nature of intermediate and deep earthquakes at U. Michigan, Academia Sinica, Taiwan, and National Taiwan U.

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In Feb. **John Chambers**, **Alycia Weinberger**, and **Scott Sheppard** gave talks at the second National Capital Area Disks Meeting organized by former postdoctoral fellow **Hannah Jang-Condell** and held at U. Maryland-College Park.

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The 40th Lunar and Planetary Science Conference was held in Mar. in The Woodlands, TX. DTM presenters included **Sean Solomon**, **Alan Boss**, **Rick Carlson**, and **Larry Nittler**, and postdoctoral fellows and associates **Ming-Chang Liu**, **Liping Qin**, **Thomas Ruedas**, and **Jessica Warren**.

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Several DTM staff and postdoctoral fellows attended the 2009 Earthscope National Meeting in Boise, ID, in May, including **Rick Carlson**, **David James**, **Paul Silver**, and postdoctoral fellows **Teh-Ru Alex Song** and **Jessica Warren**.

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The 2009 AGU Joint Assembly was held in Toronto in May. **Steve Shirey** and postdoctoral fellows and associates **Natalia Gómez Pérez**, **Teh-Ru Alex Song**, and **Wen-che Yu** were among the presenters.

DTM/GL

Chester G. Fuson's personal reminiscences and photographs documenting a 10-month magnetic survey from Beijing, China, to Bombay, India, in 1909 were donated to the DTM archives by his son, William M. Fuson. The elder Fuson was a professor of history and geography at Canton Christian College—now Lingnan U.—in Guangzhou, China, and served as chief assistant on the expedition, which was led by DTM magnetic observer **Don C. Sowers**. □

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Carnegie Gets Excellent Ratings

The Carnegie Institution received the highest rating for sound fiscal management—four stars—from Charity Navigator for the eighth year running. Charity Navigator is America's largest charity evaluator. Only four organizations out of 5,381 have received that rating eight years running.* Standard & Poor's (S&P) also reaffirmed Carnegie's credit rating of AA+, its second-highest rating. Carnegie was upgraded to AA+ from AA in 2002 by S&P and has never been downgraded. "We are very pleased about both of these evaluations," commented Richard Meserve, Carnegie president. "It is particularly challenging to maintain this level of fiscal capability in these economically difficult times."

Charity Navigator's rating system looks at how responsibly an organization functions on a day-to-day basis, as well as how well it will be able to sustain programs over time. It bases its analyses on the financial information each charity provides annually in its informational tax return (IRS Forms 990). During the last year, Carnegie spent 85.8% of its budget on its scientific programs, 12.6% on administration, and 1.5% on fundraising.

S&P's credit rating provides an independent evaluation of Carnegie's overall financial capacity. In reaching this opinion, S&P conducted an assessment of Carnegie's capacity and willingness to meet its financial commitments as they come due. By reaffirming the AA+ rating, S&P has determined that Carnegie's capacity to meet its financial commitments remains very strong even in this difficult financial climate. S&P has indicated that the current rating is based on Carnegie's sizable endowment, considerable financial resources, low debt level and manageable debt burden, and budgetary flexibility. □

**Carnegie's ranking is partially due to the fact that few organizations have been reviewed for eight consecutive years.*

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