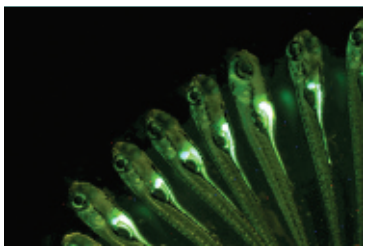
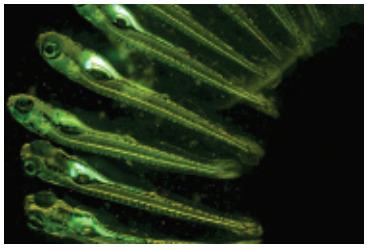
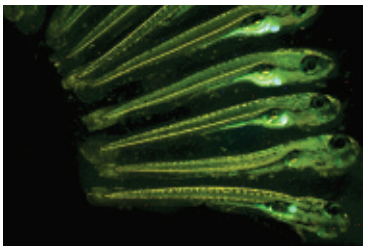
CarnegieScience

The Newsletter of the Carnegie Institution

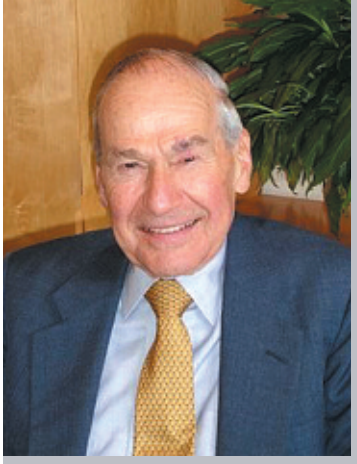
SUMMER 2008







On the Inside



A recent and sobering National Science Foundation report* quantifies a dramatically changing landscape in science and technology. The United States once was the clear leader, fueled by investment in science and engineering research and in education. Now, our dominance is challenged by other countries. Our homegrown, technically educated population is dwindling. More alarming, we are not gaining ground in science education at the lower levels.** Between 1996 and 2005, the test scores of 12th graders actually declined in basic scientific understanding, while those of eighth graders remained the same and fourth-grade scores rose slightly. Many in government and industry are very concerned that this situation threatens the long-term competitiveness of our economy.

Andrew Carnegie once said, "Only in popular education can man erect the structure of an enduring civilization." The Carnegie Institution has been dedicated to conveying the excitement and rewards of science to the public for years. In addition to providing postdoctoral training and outreach programs associated with federal grants, our departments have forged many exciting and diverse education programs.

Our longest-running effort is our Capital Science Evenings lecture series. These free public lectures at the administration building routinely fill the 400-seat auditorium. The First Light Saturday science school and the Carnegie Academy for Science Education (CASE) have also enabled hundreds of teachers and students in Washington, D.C., to learn the fun and utility of hands-on science. And we are now spearheading a collaboration for a new Washington, D.C., chapter of Math *for* America.

In 2003, the Observatories started their own lecture series in astronomy, which attracts hundreds of Southern Californians. The department also hosts two local educational programs, one with a nearby elementary school and the other, in undergraduate astronomy, with Pomona and Harvey Mudd colleges. Additionally, every year the department holds an open house to educate the local community about Carnegie astronomy.

In Northern California, the Department of Plant Biology offers summer research experiences to undergraduates from various institutions, including local community colleges and state universities. These students work full time during the summer for eight to 10 weeks, participate in a seminar series, and present their research results to the department at the end of the session.

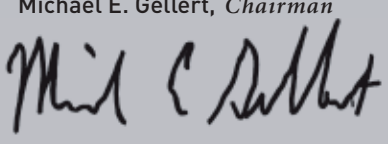
In the few short years since its founding, the Department of Global Ecology, co-located with Plant Biology, has become a leader in conducting science related to climate change and in communicating that science to governments, international organizations, the media, and the public at large.

Outreach at the Broad Branch Road campus is a collaborative effort between the Geophysical Lab and the Department of Terrestrial Magnetism. They sponsor a summer intern program in geoscience for undergraduate science majors and high school students. After completion of the new Greenewalt Building, they started a neighborhood lecture series, which has just completed its second successful year.

The Department of Embryology in Baltimore has trained graduate students since its inception in 1914. Today students can learn in any of the department's seven laboratories. Recently, Steve Farber started the innovative BioEYES program, which engages elementary, middle, and high school students in science as they observe how transparent zebrafish develop. Other individuals across the institution are likewise dedicated to this type of grassroot effort.

These few examples demonstrate that Carnegie scientists seek to promote widespread understanding of the power and delight of scientific research. I thank everyone in the institution who has taken the time for this important work. We must prepare the next generations for a world that will be far different from today's. And Andrew Carnegie's vision has provided us with the foundation to continue this vital role.

Michael E. Gellert, *Chairman*



*National Science Foundation, National Science Board, *Science and Engineering Indicators 2008.*
http://www.nsf.gov/statistics/seind08/c2/c2s5.htm

**U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996, 2000, and 2005 Science Assessments.
http://nces.ed.gov/nationsreportcard/pubs/main2005/2006466.asp

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"Big Telescopes" at Carnegie Evening

(Left) Christos Hadidiacos of the Geophysical Laboratory was recognized as the first recipient of Carnegie's Service to Science Award before the Carnegie Evening lecture.

(Top Right) Carnegie Evening speaker Stephen Shectman

Beginning with Galileo some four centuries ago, astronomers have sought bigger and better telescopes to scan the heavens. For this year's Carnegie Evening lecture at the administration building in Washington, D.C., Stephen Shectman of the Observatories gave his perspective on that quest in a talk titled "Big Telescopes of Today and the Giant Telescopes of Tomorrow."

Shectman noted that Galileo's telescope had an aperture of about one inch, while today's largest telescopes have apertures of about 400 inches (10 meters). This 400-fold increase in aperture over 400 years, plus improvements in instrumentation, has boosted the total light-gathering capacity of telescopes by a factor of 1.6 billion.

But progress has not been an inch-by-inch, year-by-year affair. In the mid-20th century, big telescopes hit a practical limit. The technology did not exist to produce highly precise and highly stable mirror surfaces of diameters larger than about 19.5 feet (6 meters). And the atmosphere posed another barrier. Air turbulence generally limits the resolution of even the largest telescopes to about one arc-second (1/3600th of a degree).

The great leap in the development of large telescopes came in the 1990s, when telescopes were built using three different solutions to the problem of large mirrors. Ultrathin meniscus mirrors, lightweight honeycomb mirrors, and segmented mirrors now make it possible to produce mirrors up to 33 feet (10 meters) and larger, and advances in polishing technology yield highly uniform surfaces. New compact telescope structures minimize wobble from wind forces, and sophisticated "active optics" systems adjust the mirror's shape in real time to compensate for distortions by gravity and temperature.

About a dozen large telescopes were built using these technologies in the 1990s. Among them were the Magellan telescopes at the Las Campanas Observatory, developed by Carnegie and its partners. Shectman gave a stage-by-stage account of the telescopes' construction, including the harrowing journey of the delicate mirrors from the polishing lab in Arizona to their final position on a Chilean mountaintop. The initial telescope's first image had an astonishing resolution of 0.5 arc-seconds—a dramatic validation of the new optical technologies.

Shectman told the audience that even better resolution lies ahead. Telescopes with "adaptive optics" will actively compensate for atmospheric turbulence, and new instruments promise greater sensitivity. The Giant Magellan Telescope currently being developed will have the power of an 80-foot (24.5-meter) mirror, marking the next generation of telescopes and a new stage of human exploration of the universe. □

TrusteeNews

Carnegie Board Meets in Washington

The 128th meeting of the Carnegie board of trustees began on May 1, 2008, at the administration building. It followed the Carnegie Evening lecture the night before by Stephen Shectman, who talked about the large telescopes of today and the next-generation giant telescopes of tomorrow. The Employee Affairs committee kicked off the session Thursday morning. Their gathering was followed by Finance committee and Development committee meetings. The first full session of the board met that afternoon. Then trustees and guests gathered for the second Annual Carnegie Dinner to top off the day. Friday morning, the second session of the full board met. □

Appreciating Andrew

By Jason Gebhardt

Carnegie celebrated another exceptional year with its annual dinner at the administration building on May 1, 2008, held in conjunction with the May meetings of the board of trustees. Highlights of the evening were a presentation by Cristián Samper, Acting Secretary of the Smithsonian, and a premiere of a piano composition honoring Andrew Carnegie.

Board chairman Michael Gellert welcomed guests, highlighting numerous accomplishments over the last year, including the participation of Carnegie scientists in the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with Al Gore.

President Meserve then acknowledged the financial support received over the past year from Carnegie's community of friends and he recognized Carnegie's philanthropic society members present at the dinner. Barbara McClintock Society members—individuals who have made gifts totaling at least $10,000 within a fiscal year—included John Botts, Michael Brin, John Crawford, Bruce Ferguson, Martin Gellert, Michael Gellert, Griselda Hale, Robert and Margaret Hazen, Paul and Carolyn Kokulis, Steve McKnight, Jaylee Mead, Marty Meserve, Al and Honey Nashman, Deborah Rose, Christopher Stone, Bill Turner, and Jim Weinberg. Meserve then inducted former Embryology scientist Nina Fedoroff, now science adviser to the Secretary of State, into the Second Century Society, which honors those who have made a planned gift or included Carnegie in their estate plans.

Meserve talked about the important contributions of the lifetime giving societies, particularly noting Edwin Hubble Society members Michael Gellert, Jaylee Mead, Deborah Rose, and Jim Weinberg. The Hubble Society honors those who have made lifetime contributions of $1 million or more. Meserve then acknowledged Vannevar Bush Society members Tom Cori, Bruce Ferguson, Steve Fodor, Robert and Margaret Hazen, Steve McKnight, Marty Meserve, Al and Honey Nashman, Christopher Stone, and Bill Turner. Vannevar Bush Society members have made lifetime contributions of $100,000 or more.

After dinner, biologist Cristián Samper spoke about his vision for the Smithsonian's future, emphasizing the essential importance of strong partnerships in the scientific community. He lauded the 104-year history of collaboration between the Smithsonian and Carnegie institutions as an example and expressed his excitement over the Smithsonian Astrophysical Observatory's participation in the Carnegie-led Giant Magellan Telescope project.

The evening continued with a piano piece titled "Appreciating Andrew," composed and performed by scientist and educator Marion O'Leary. O'Leary joined Carnegie in January 2008, as the senior advancement adviser for Carnegie's Global Ecology fund-raising campaign.

The 2008 Annual Dinner concluded with President Meserve presenting baseball caps sporting Carnegie's new "Carnegie Institution for Science" logo to all dinner attendees. □

Before dinner, senior trustee and Edwin Hubble Society member Jim Weinberg poses with (from left to right) Observatories director Wendy Freedman, McClintock Society member Martin Gellert, Carnegie president Richard Meserve, and the speaker for this year's annual dinner, Acting Secretary of the Smithsonian Institution, Cristián Samper.

Trustee Tom Cori (left), Carnegie president Richard Meserve (middle), and former Embryology staff scientist and Second Century Society member Nina Fedoroff chat before dinner.

(Left image) Hubble Society member and Carnegie trustee Jaylee Mead (left) poses with McClintock Society member Griselda Hale. (Right image) Deborah Rose is secretary of the Carnegie board of trustees and is a member of the Edwin Hubble Society.

Trustee and Vannevar Bush Society member Steve McKnight, formerly a scientist at Embryology, listens to the evening's entertainment with Marty Meserve, wife of Carnegie president Richard Meserve.

Images courtesy Jim Johnson

Global Limits of Biomass Energy

Biomass energy—energy generated from agricultural waste or specially grown energy crops—has been widely touted as a clean, renewable alternative to fossil fuels. Research is booming to improve energy crops and methods of converting crops to fuel. Already, Brazil gets 30% of its automotive fuel from ethanol distilled from sugar cane. But critics warn that "energy farming" will gobble up land needed to grow food or will impinge on natural ecosystems, possibly even worsening the climate crisis.

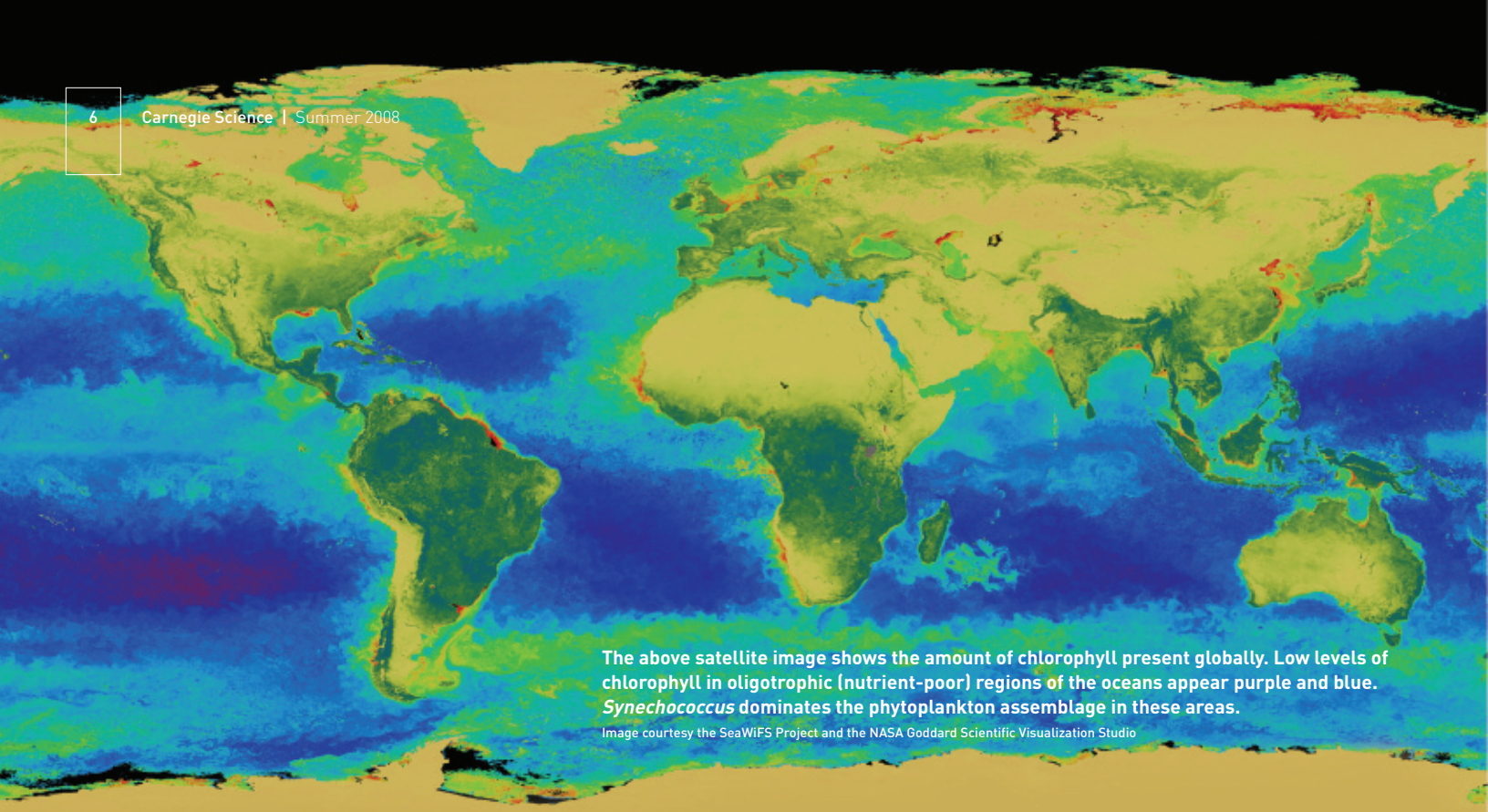
In the February *Trends in Ecology and Evolution*, Global Ecology director Chris Field, with postdoctoral fellow Elliott Campbell and a colleague, took a sober look at the prospects for biomass energy. They found that while biomass has many benefits—in principle it can be carbon neutral—there are limits to the extent that it can sustainably contribute to global energy needs. For example, the total mass of carbon fixed by all croplands worldwide each year (about 7 billion tons) is still less than that released by fossil fuel emissions (7.7 billion tons). This fact, the authors write, "highlights the challenge of replacing a substantial part of the fossil fuel system with a system based on biomass."

The researchers used a combination of historical data, satellite imagery, and productivity models to determine best-case estimates of potential yields and of how much biomass could sustainably contribute to the world's energy needs while also mitigating global warming.

"The area with the greatest potential for yielding biomass energy that reduces net warming and avoids competition with food production is land that was previously used for pasture, but that has been abandoned and not converted to forest or urban areas," they write.

Globally, suitable abandoned cropland and pastureland amounts to approximately 1.5 million square miles. Realistically, energy crops raised on this land could be expected to yield about 27 exajoules of energy each year. This is a huge amount of energy—an exajoule is a billion billion joules, equivalent to 172 million barrels of oil. Yet the biomass yield could still satisfy only about 5% of global primary energy consumption by humans, which in 2005 was 483 exajoules.

The study concludes that at a proper, sustainable scale, biomass energy presents exciting opportunities for increasing energy independence, sustaining farm economies, and decreasing the forcing of climate change. But deployed at a larger scale, it could threaten food security and exacerbate climate change. ☐



The above satellite image shows the amount of chlorophyll present globally. Low levels of chlorophyll in oligotrophic (nutrient-poor) regions of the oceans appear purple and blue. *Synechococcus* dominates the phytoplankton assemblage in these areas.

Image courtesy the SeaWiFS Project and the NASA Goddard Scientific Visualization Studio

NEW TWIST ON LIFE'S POWER SOURCE

Photosynthesis

is arguably the most important biological process on Earth. Through photosynthesis, plants, algae, and some bacteria support nearly all living things by producing food from sunlight. In the process, they alter the atmosphere by releasing oxygen and absorbing carbon dioxide. But two studies by Plant Biology's Arthur Grossman and colleagues, reported in *Biochimica et Biophysica Acta* and *Limnology and Oceanography*, suggest that certain marine microorganisms have evolved a way to break the rules—they get a significant proportion of their energy without a net release of oxygen or uptake of carbon dioxide. This discovery impacts not only scientists' basic understanding of photosynthesis, but importantly, it may also impact how microorganisms in the oceans affect rising levels of atmospheric carbon dioxide.

Grossman's team investigated photosynthesis in a marine *Synechococcus*, a genus of cyanobacteria (formerly called blue-green algae). *Synechococcus* dominates phytoplankton populations over much of the world's oceans and is an important contributor to global primary productivity. Grossman and his colleagues wanted to understand how *Synechococcus* could thrive in the iron-poor waters that make up large areas of the ocean, since certain activities of normal photosynthesis require high levels of iron. Other workers had suggested a potential role for oxygen in accepting electrons from the photosynthetic apparatus in place of carbon dioxide, and the studies by Grossman's group show that this activity is indeed significant in the oligotrophic (nutrient-poor) oceans, which cover about half the Earth's ocean area.

"It seems that *Synechococcus* in the oligotrophic oceans has solved the iron problem, at least in part, by short-circuiting the standard photosynthetic process," says Grossman. "Much of the time, this organism bypasses stages in photosynthesis that require the most iron. As it turns out, these are also the stages in which carbon dioxide is taken from the atmosphere."

"We realized very quickly that there was something different about the *Synechococcus* that we were studying," says Shaun Bailey, the lead postdoctoral fellow working on this project. "The uptake of carbon dioxide and the photosynthetic activities didn't match, so we knew that something other than carbon dioxide was being consumed by photosynthesis, and it

turned out to be oxygen." The researchers have tentatively identified the enzyme involved in this process to be plastoquinol terminal oxidase, or PTOX. They point out that this new process must be considered to understand the primary productivity of ocean ecosystems.

During normal photosynthesis, light energy splits water molecules. This releases oxygen and provides electrons that are then used to "fix" carbon dioxide from the atmosphere and manufacture energy-rich molecules such as sugars. In the newly discovered process, a large proportion of these electrons are not used to fix carbon dioxide but instead go to putting the water molecules back together, which results in much less net oxygen production.

"It might seem like the cells are just doing a futile light-driven water-to-water cycle," says Bailey. "But this is not really true since this novel cycle is also a way of using sunlight to produce energy, while protecting the photosynthetic apparatus from damage that can be caused by the absorption of light."

Capturing energy by a light-driven water-to-water cycle is critical since marine cyanobacteria are constantly using energy to acquire nutrients from the meager supply in their environment. Recently, this newly discovered phenomenon was shown to occur in nature by Stanford University graduate student Kate Mackey, who made direct measurements of photosynthesis in field samples from the Atlantic and Pacific oceans.

"The low-nutrient, low-iron environments represent a large portion of the Earth's surface available for photosynthesis," says Mackey. "Our findings show that this novel cycle occurs in two major ocean basins and suggest that a substantial amount of energy from sunlight gets rerouted away from carbon fixation during photosynthesis. This may mean that less carbon dioxide is being removed from the atmosphere by the open-ocean photosynthetic organisms than was previously believed."

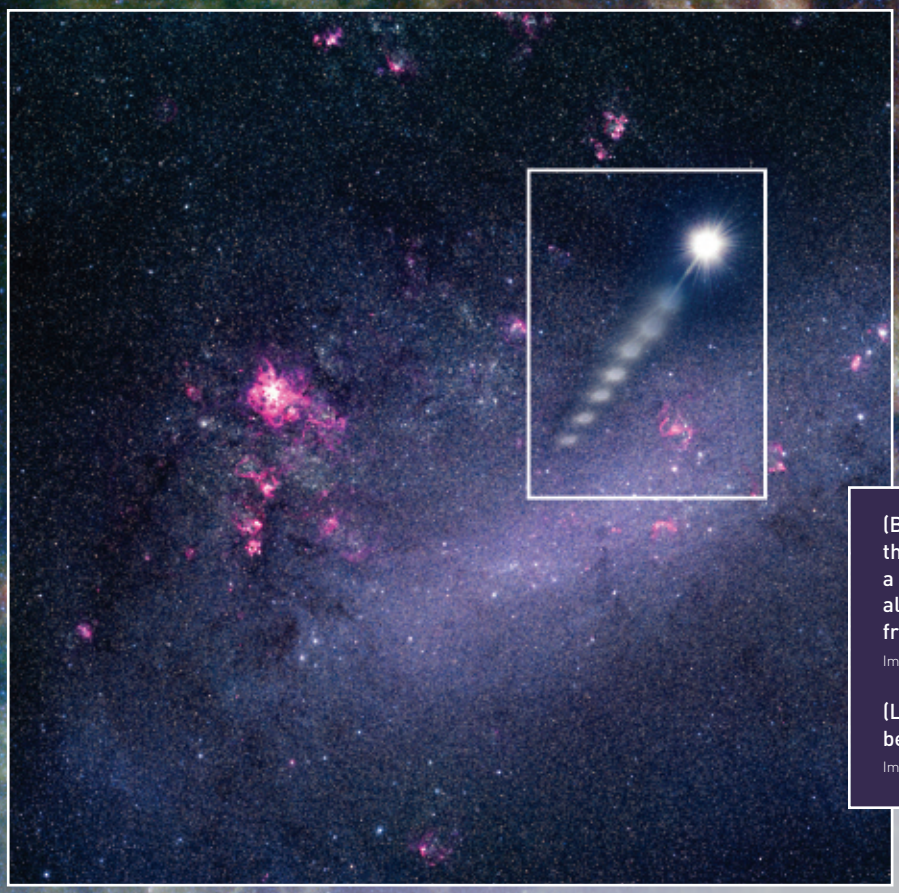
"This discovery represents a paradigm shift in our view of photosynthesis by organisms in the vast, nutrient-starved areas of the open ocean," says Joe Berry of Carnegie's Department of Global Ecology. "We had assumed that, like higher plants, the goal was to make carbohydrates from carbon dioxide and store them for later use as a source of energy for any number of cellular functions or growth. We now know that some organisms short-circuit this complicated process, using light in a minimalist way to power cellular processes directly with a far simpler and cheaper (in terms of scarce nutrients such as iron) photosynthetic apparatus. We don't know the full significance of this finding yet, but it is certain to change the way we interpret optical measurements of photosynthetic pigments in the ocean and the way we model ocean productivity."

Plant Biology acting director Wolf Frommer agrees about the discovery's groundbreaking importance. "If we thought we have understood photosynthesis, this study proves that there is much to be learned about these basic physiological processes. The findings of Grossman's laboratory together with previous evidence reported by Greg Vanlerberghe from the University of Toronto, showing that the gene encoding PTOX appears to be widespread in marine cyanobacteria, will add depth and a mechanistic foundation for the modeling of primary productivity in the ocean." □

Arthur Grossman (left) and Shaun Bailey (right) discovered that the widespread marine cyanobacterium *Synechococcus* can short-circuit normal photosynthetic pathways to produce energy without absorbing carbon dioxide.
Image courtesy Shaun Bailey

Stanford graduate student Kate Mackey used field samples from the Atlantic and Pacific oceans to confirm that the novel photosynthetic process occurs in natural populations of *Synechococcus*.
Image courtesy Kate Mackey

Hyperfast Alien Found Out



(Background) NASA's Spitzer Space Telescope took this infrared image of the Large Magellanic Cloud, a neighboring galaxy of our Milky Way, where the alien star originated. It is about 160,000 light-years from Earth.

Image courtesy NASA/JPL-Caltech/STScI

(Left) This is an artist's rendition of the alien star being ejected from the Large Magellanic Cloud.

Image courtesy ©ESO

Where did a young superfast star zipping away from the Milky Way come from? Terrestrial Magnetism postdoctoral fellows Alceste Bonanos and Mercedes López-Morales, with collaborators, have solved this celestial puzzle. Based on its age, this star could not have come from our galaxy. By analyzing the star's velocity, light intensity, and, for the first time, telltale elemental composition, the researchers determined that it came from our neighboring galaxy, the Large Magellanic Cloud (LMC). They also found that it was ejected from that galaxy by a yet-to-be-observed massive black hole. The research was published in *Astrophysical Journal Letters* and covered by various media outlets.

There are only ten known so-called hypervelocity stars speeding away from the Milky Way. The one the scientists studied, dubbed HE 0437-5439, is an early-type star. "But this one is different from the other nine," comments López-Morales. "The others' type, speed, and ages make them consistent with having been ejected from the center of our galaxy, where we know there is a supermassive black hole. This star, discovered in 2005,* initially appeared to have an elemental makeup like our Sun's, suggesting that it, too, came from the center of our galaxy. But that didn't make sense because it would have taken 100 million years to get to its location, and HE 0437-5439 is only 35 million years old."

To explain this "paradox of youth," the star's original discoverers proposed that HE 0437-5439 was either a so-called blue straggler—a relatively young, massive star resulting from the merger of two low-mass stars from the Milky Way—or it had originated from the Large Magellanic Cloud.

"We were intrigued by the conundrum and decided to take up the challenge," states Bonanos. "Stars in the LMC are known to have lower elemental abundances than most stars in our galaxy, so we could determine if its chemistry was more like that galaxy's or our own."

The team confirmed results of the previous study concerning the mass, age, and speed of the star. It is about nine times the mass of our Sun, about 35 million years old, and it is zooming away from the Milky Way and Large Magellanic Cloud into intergalactic space at 1.6 million miles per hour (2.6 million km/hr).

Alceste Bonanos is a Vera C. Rubin Fellow at the Department of Terrestrial Magnetism. She received her Ph.D. from Harvard University in astronomy in 2005.
Image courtesy Alceste Bonanos

Hubble Fellow Mercedes López-Morales at the Department of Terrestrial Magnetism received her Ph.D. in astrophysics from the University of North Carolina, Chapel Hill, in 2004.
Image courtesy Mercedes López-Morales

Although the previous study was able to roughly estimate the star's elemental composition, the measurements were not detailed enough to determine whether the elements match stars in our galaxy or are characteristic of stars from the Large Magellanic Cloud. The Carnegie astronomers were able to measure the relative abundances of certain elements for the first time for any hypervelocity star. The relative abundance of key elements tells them where a star originated.

"We've ruled out that the star came from the Milky Way," explains Bonanos. "The concentration of elements in Large Magellanic Cloud stars are about half those in our Sun. The fingerprints point to an origin in the Large Magellanic Cloud."

Based on the speed of the star's rotation, measured by the discoverers and confirmed by this team, the astronomers believe that the star was originally part of a binary system. The binary could have passed close to a black hole 1,000 times the mass of the Sun.* As one star was pulled into the black hole, the other was whipped into a frenzy and flung out of the galaxy.

"This is the first observational clue that a massive black hole exists somewhere in the LMC. We look forward to finding out where this black hole might be," concludes Bonanos. □

*The discovery of HE 0437-5439 was published in *Astrophys. J. 634*, L191-L184, 2005. The work predicting that a black hole of 1,000 solar masses is necessary to eject the star can be found in *Mon. Not. Roy. Astron. Soc. Lett. 376*, L29-L33, 2007.

Alceste Bonanos acknowledges research and travel support from the Carnegie Institution for Science through a Vera Rubin Fellowship. Mercedes López-Morales acknowledges support provided by NASA through Hubble Fellowship grant HF-01210.01-A, awarded by the Space Telescope Science Institute (STScI).

Red Dust in Planet-Forming Disk May Harbor Precursors to Life

Carnegie astronomers have found the first indications of highly complex organic molecules in the disk of red dust surrounding a distant star. The eight-million-year-old star, known as HR 4796A, is inferred to be in the late stages of planet formation, suggesting that the basic building blocks of life may be common in planetary systems.

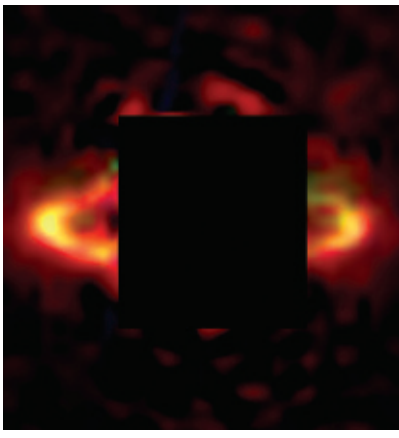
In a study published in the *Astrophysical Journal Letters*, John Debes and Alycia Weinberger of the Department of Terrestrial Magnetism with Glenn Schneider of the University of Arizona report observations of infrared light from HR 4796A. Using the Near-Infrared Multi-Object Spectrometer aboard the Hubble Space Telescope, the researchers found that the spectrum of visible and infrared light scattered by the star's dust disk looks very red, the color produced by large organic carbon molecules called tholins. The spectrum does not match those of other red substances, such as iron oxide.

Tholins do not form naturally on present-day Earth because oxygen in the atmosphere would quickly destroy them, but they are hypothesized to have existed on the primitive Earth billions of years ago and may have been precursors to the biomolecules that make up living organisms. Tholins have been detected elsewhere in the Solar System, such as in comets and on Saturn's moon Titan, where they give the atmosphere a red tinge. This study is the first report of tholins outside the Solar System.

"Until recently it's been hard to know what makes up the dust in a disk from scattered light, so to find tholins this way represents a great leap in our understanding," says Debes.

HR 4796A is located in the constellation Centaurus, visible primarily from the Southern Hemisphere. It is about 220 light-years from Earth. The discovery of its dust disk in 1991 generated excitement among astronomers, who consider it a prime example of a planetary system caught in the act of formation. The dust is generated by collisions of small bodies (perhaps similar to the comets or asteroids in our Solar System), which may be coated by the organics. These planetesimals can deliver these building blocks for life to any planets that may also be circling the star.

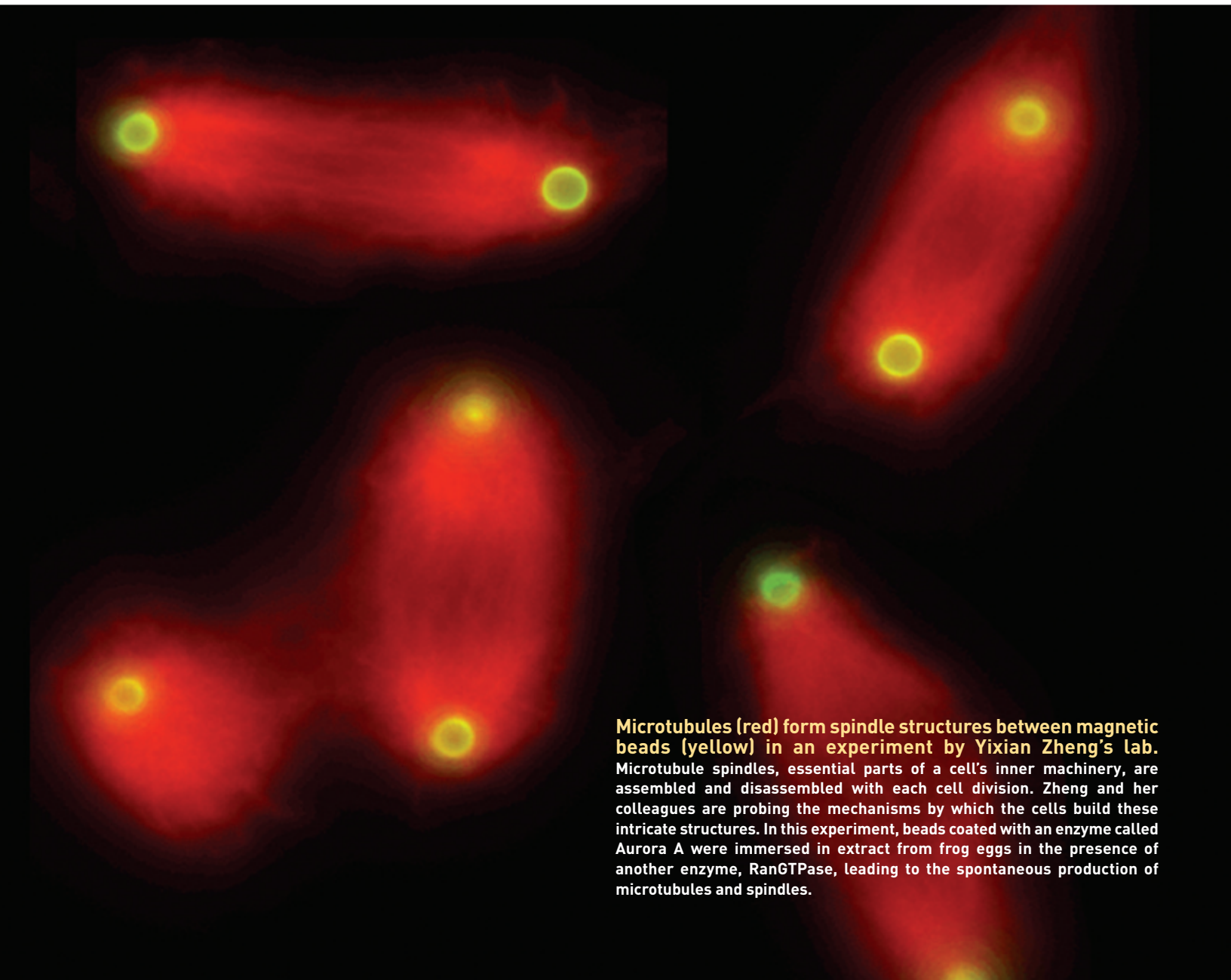
"Astronomers are just beginning to look for planets around stars much different from the Sun. HR 4796A is twice as massive, nearly twice as hot as the Sun, and twenty times more luminous than the Sun," says Debes. "Studying this system provides new clues to understanding the different conditions under which planets form and, perhaps, life can evolve." □



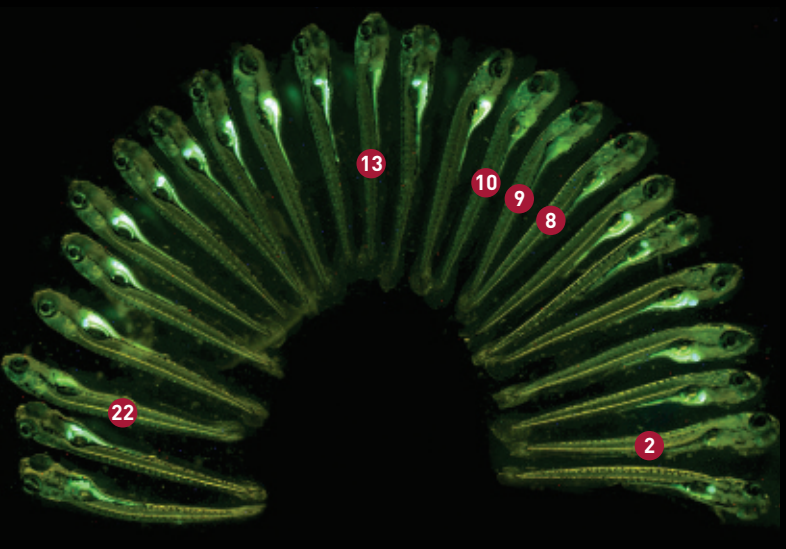
Red and near-infrared wavelengths from the dust disk surrounding the star HR 4796A (masked in this false-color image to make the fainter disk visible) suggest the presence of complex organic molecules. The inner "hole" of the ring-shaped disk is big enough to fit our entire Solar System and may have been swept clean of dust by orbiting planets.
Image courtesy John Debes

A FEAST FOR THE EYES AS WELL AS THE MIND

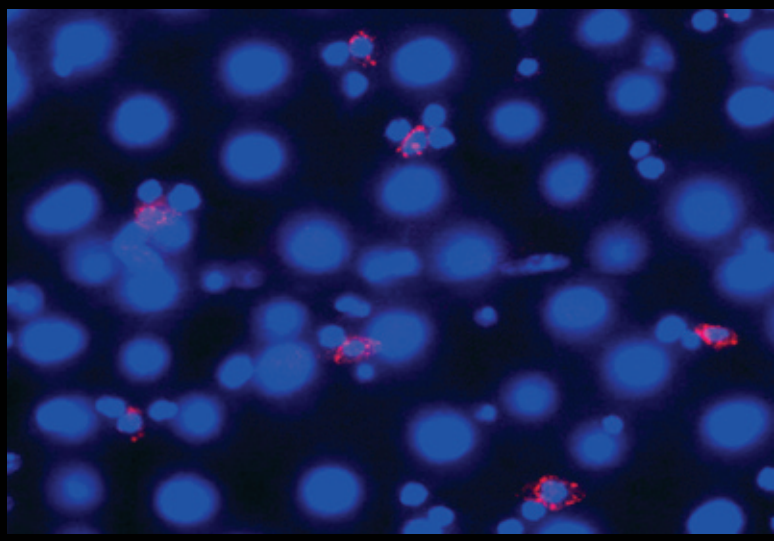
While exploring the inner world of cells, genes, and development, Department of Embryology researchers find scientific insights and visions of uncanny beauty. Over the past few years, visitors to the department's home page have been greeted by a series of striking photographs taken by the scientists and assembled by information technology manager Bill Kupiec. Here are six of the best.



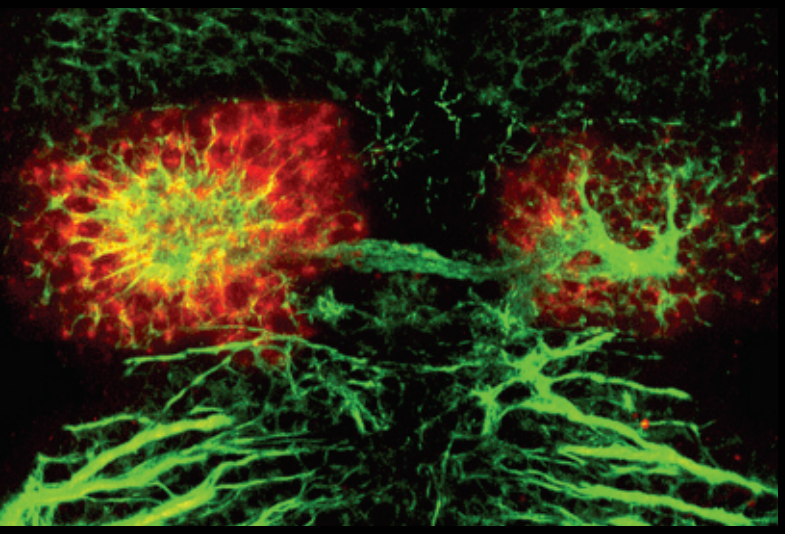
Microtubules (red) form spindle structures between magnetic beads (yellow) in an experiment by Yixian Zheng's lab. Microtubule spindles, essential parts of a cell's inner machinery, are assembled and disassembled with each cell division. Zheng and her colleagues are probing the mechanisms by which the cells build these intricate structures. In this experiment, beads coated with an enzyme called Aurora A were immersed in extract from frog eggs in the presence of another enzyme, RanGTPase, leading to the spontaneous production of microtubules and spindles.



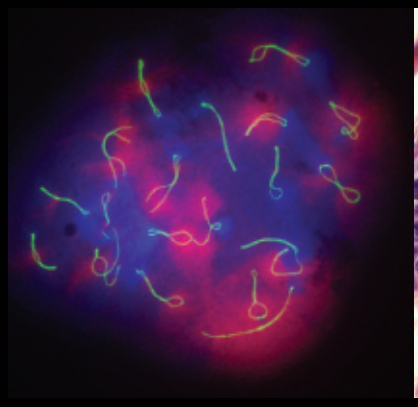
Tagged with fluorescent molecules, the glowing guts of five-day-old zebrafish larvae reveal their ability to digest lipids. Steve Farber uses live zebrafish to study digestive physiology. In this experiment, a mutant gene known as *fat free* reduces phospholipid and cholesterol processing. Six of the 24 fish larvae in the photo are mutants. (From the right, they are numbers 2, 8-10,13, and 22.)

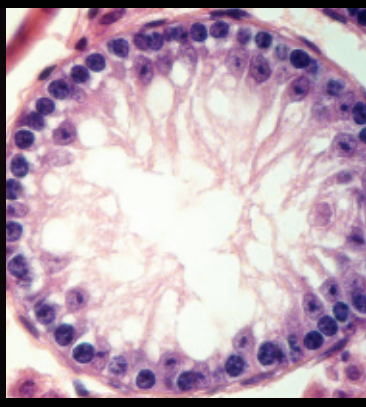


Amid the blue glow of DNA, red-tagged proteins identify stem cells in the intestines of a fruit fly. Despite their importance, stem cells are often difficult to distinguish from other cells. Allan Spradling and collaborators found that intestinal stem cells have large amounts of a protein known as Delta on their surfaces. Tagging the Delta proteins with fluorescent marker molecules allowed the team to single out intestinal stem cells and to discover that they determine the fates of their daughter cells.



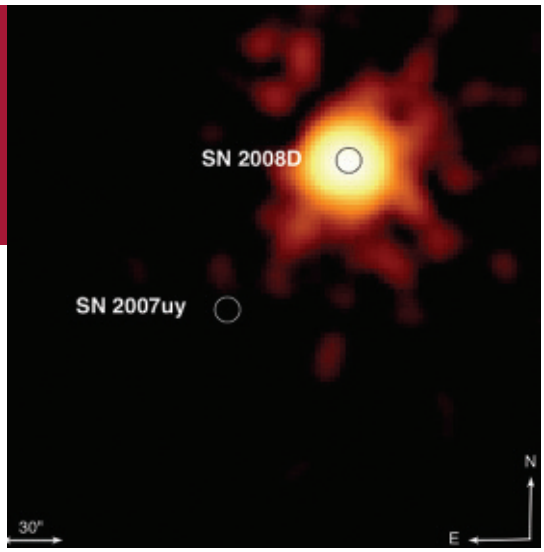
Left-right differences in the developing brain show up dramatically in a zebrafish larva. To trace the genetic origins of brain laterality, Marnie Halpern and colleagues use genes such as *leftover*, marked to glow red in tissues where it is expressed. The photo shows that *leftover* is strongly expressed on the left side but only weakly expressed on the right.

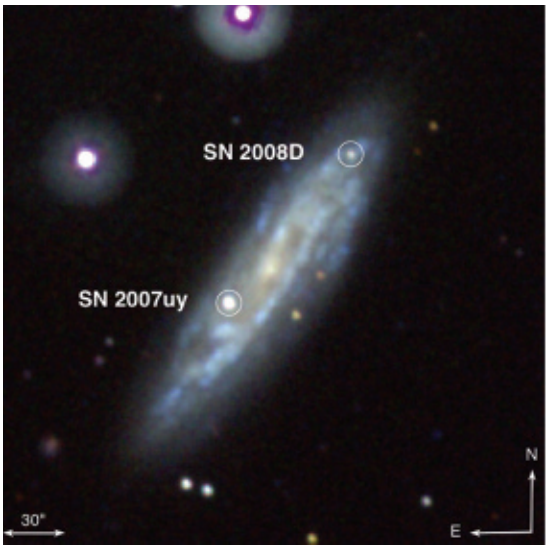




Meiotic "mayhem" lights up male germ cells as jumbled chromosomes emit a distress signal (red). During the complicated cell divisions of meiosis, matching parental chromosomes are usually held together by a proteinaceous strand called the synaptonemal complex (green). In the mutant cells studied by Alex Bortvin's lab, the formation of this complex has gone awry, as seen by the contorted green lines in the photo. The disruption of cell division is fatal to the cells.

Only immature male germ cells are found in tubules of the testis of a mouse lacking the evocatively named *maelstrom* gene. In a normal mouse, the tubule would be crammed with cells at different stages of maturation (far right). But in the mutant shown in this photo from Alex Bortvin's lab, there are only two rows, indicating *maelstrom*'s key role in sperm production.





On January 9, 2008, NASA's Swift observatory caught a bright X-ray burst from an exploding star. Carnegie-Princeton fellows Alicia Soderberg and Edo Berger were on hand to witness this first-of-its-kind event. A few days later, SN 2008D appeared in visible light.

Image courtesy NASA/Swift Science Team/Stefan Immler

Supernova Birth Seen for First Time

Astronomers have seen the aftermath of spectacular stellar explosions known as supernovae before, but until now no one has witnessed a star dying in real time. While using NASA's orbiting Swift telescope to look at another object in the spiral galaxy NGC 2770, Alicia Soderberg and Edo Berger, Carnegie-Princeton Fellows* at the Observatories, detected an extremely luminous blast of X-rays released by a supernova explosion. They alerted eight other orbiting and on-ground telescopes to turn their eyes on this first-of-its-kind event. The research appeared in the May 22 issue of *Nature* magazine.

"We were in the right place, at the right time, with the right telescope on January 9th and witnessed history," remarked Soderberg. "We were looking at another, older supernova in the galaxy, when the one now known as SN 2008D went off. We would have missed it if it weren't for Swift's real-time capabilities, wide field of view, and numerous instruments."

Supernovae are the explosions of massive stars—stars more than eight times the mass of the Sun—whose cores run out of nuclear fuel and collapse in on themselves to form a neutron star or a black hole. In the process, they launch a powerful shock wave that blows up the star. Until now, observations of these objects have been of the aftermath, typically several days after the initial explosion—not the first instance of death. Astrophysicists predicted nearly four decades ago that the first sign of a supernova would be an X-ray blast, but none had been witnessed before Soderberg's and Berger's Swift observations.

"Using the most powerful radio, optical, and X-ray telescopes on the ground and in space, we were able to observe the evolution of the explosion right from the start," said Berger. "This eventually confirmed that the big X-ray blast marked the birth of a supernova."

This massive, across-the-spectrum team of collaborators looked at SN 2008D for more than 30 days to rule out the possibility that the event was something other than a supernova. They also determined that the object is a typical Type Ibc supernova, and they measured the size of the star prior to the explosion.

Researchers now know what X-ray pattern to look for, which raises the potential for finding a large number of supernovae at the time of explosion and opens up avenues of research that previously seemed nearly impossible. In particular, determination of the exact explosion time will allow searches for neutrino and gravitational wave bursts that are predicted to accompany the collapse of the stellar core and the birth of the neutron star.

"The next generation of X-ray satellites will find hundreds of supernovae every year exactly when they explode," said Soderberg. "I am thrilled that our discovery is leading this new wave of astronomy." □

*Carnegie-Princeton Fellows are postdoctoral fellows who share their time at the Carnegie Observatories and Princeton University. At top is Alicia Soderberg; at bottom is Edo Berger.

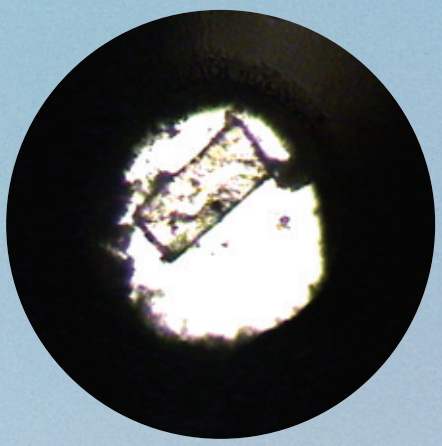
Images courtesy Alicia Soderberg and Edo Berger

Squeezed Crystals
Deliver More Volts Per Jolt

A discovery by Carnegie scientists has opened the door to a new generation of piezoelectric materials—materials that can convert mechanical strain into electricity and vice versa—potentially cutting costs and boosting performance in myriad applications ranging from medical diagnostics to green energy technologies.

High-performance piezoelectric materials used today are specially grown crystals of mixed composition known as solid solutions, making them difficult to study and expensive to manufacture. But in the January 31 issue of *Nature*, a research team led by the Geophysical Laboratory's Ronald Cohen and Russell Hemley reported that at high pressure, pure crystals of lead titanate show the same transitions seen in more complex materials. Moreover, theory predicts that lead titanate under pressure has the largest piezoelectric response of any material known. This suggests the exciting possibility of low-cost but extremely high-performance piezoelectrics.

"The most useful piezoelectric materials have a critical range of compositions called the morphotopic phase boundary, where the crystal structure changes and the piezoelectric properties are maximal," says Muhtar Ahart, lead author of the paper. "These are usually complex, engineered solid solutions. But we showed that a pure compound can display a morphotopic phase boundary under pressure."



A single crystal of pure lead titanate is shown in the diamond anvil cell. At high pressure, such crystals are capable of the highest piezoelectric response of any known substance. This discovery opens the door to a new generation of low-cost, high-performance piezoelectric materials, with potential applications ranging from medical imaging to green energy "harvesting."

Image courtesy Muhtar Ahart

For the study, the researchers placed powdered crystals of lead titanate in a diamond anvil cell and used high-energy X-ray beams of the Advanced Photon Source at Argonne National Laboratory to monitor the changes in the crystal structure under pressure. Using these data and calculations based on first-principle theoretical computations, the researchers determined the piezoelectric properties of the pure crystals at different pressures.

"It turns out that complex microstructures or compositions are not necessary to obtain strong piezoelectricity," says Ahart.

The use of piezoelectrics has boomed in recent years and is rapidly expanding. Their ability to convert mechanical energy to electric energy and vice versa has made them invaluable for acoustic transducers for sonar and medical ultrasound applications and for tiny, high-precision pumps and motors for medical and other devices. High-performance piezoelectrics have also opened up new possibilities for "energy harvesting," using ambient motion and vibration to generate electricity where batteries or other power sources are impractical or unavailable.

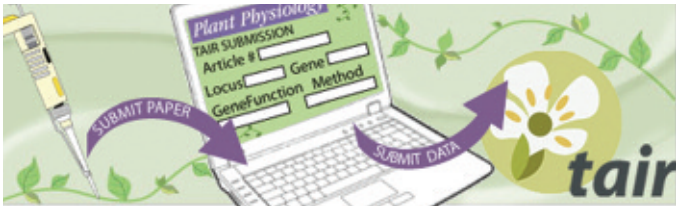
"This is a field in which theory, experiment, and material development work side by side," says Cohen. "Delineating the underlying physics of piezoelectric materials will make it easier to develop new materials and improve existing ones. We're now poised on the edge of hugely expanded applications of these technologies." □

Muhtar Ahart runs the Brillouin Spectroscopy Laboratory at the Geophysical Lab. He was lead author on the *Nature* paper reporting the unprecedented piezoelectric properties of lead titanate crystals.

Image courtesy Muhtar Ahart

This work was sponsored by the Office of Naval Research. Support was also received from the Carnegie/Department of Energy Alliance Center (CDAC). High-pressure X-ray diffraction at the HPCAT facility of the Advanced Photon Source was supported by DOE-BES, DOE-NNSA (CDAC), and the W. M. Keck Foundation. Use of the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Basic Energy Sciences.

Unclogging the Information Highway



Under the joint TAIR/*Plant Physiology* partnership, authors will submit gene information to TAIR upon a paper's acceptance to the journal.

Image courtesy TAIR

How often does the information age feel like information overload? Well, Sue Rhee and Eva Huala, at The Arabidopsis Information Resource (TAIR) at the Department of Plant Biology, are solving this dilemma: they have joined forces with the journal *Plant Physiology* to tame data input.

TAIR is one of the world's most widely used biological databases. Researchers from over 120 countries use it to study the model plant *Arabidopsis*, a variety of mustard, to advance our understanding of the fundamental processes of plants. These studies provide insights that could enhance the world's food supply, develop disease- and drought-resistant crops, and much more. The database has grown from 100,000 Web page hits per month in 2000 to over 1 million per month in 2007.

"We simply do not have the people-power to cope with entering all the research data coming from the plant biology community," remarked TAIR director Eva Huala. "We've had to triage which information goes in."

TAIR director Eva Huala (left) works with Julie Tacklind (middle), formerly at Plant Biology, and TAIR principal investigator Sue Rhee (right).

Image courtesy Sue Rhee

Given the information avalanche, TAIR principal investigator Rhee and Huala approached the journal in May of 2007 about the partnership. "It's huge for us and plant biologists everywhere," stated Rhee. "It will increase our data input from this journal from about 25% to 100%."

This first-of-its-kind partnership cuts out the middle person for entering important genetics and other biological data about plants into the database. Now authors publishing in *Plant Physiology*, a journal of the American Society of Plant Biologists, will enter their own information directly through a specially designed Web interface when their papers are accepted. The new interface went live on February 27 and promises to unclog the information highway, significantly increasing the data contained in TAIR.

Wolf Frommer, acting director of Plant Biology and VP of the Feedstocks Division of the Joint BioEnergy Institute in Emeryville, California, emphasizes the immense importance of this partnership for the development of the emerging biofuels industry. "*Arabidopsis* is the most advanced reference plant, and TAIR's efforts will certainly have a major impact for the identification of novel feedstock crops that will enable us to use plant cell walls (cellulose) as an energy source," he said.

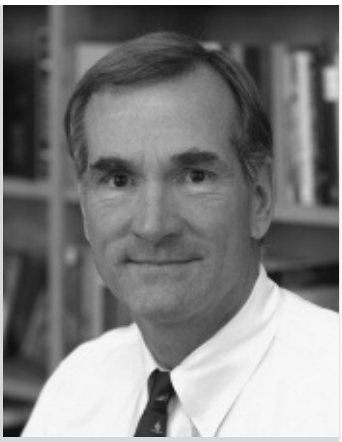
The group hopes the partnership will become a model for other disciplines. "We are pleased that TAIR selected us for what we think will be a successful partnership that other biological databases and journals can emulate to increase the flow of information and data dissemination within the research community," wrote *Plant Physiology* editor-in-chief Donald Ort with Aleel Grennan in a journal editorial.

Looking to the future, Huala said, "If a few more journals jump on this bandwagon, TAIR could provide complete coverage of all published *Arabidopsis* data within a few years. Currently only about 27% of articles with data on *Arabidopsis* genes have had their data extracted." □

For more information on the project, see http://www.plantphysiol.org/cgi/content/full/146/3/1022?etoc

*The Arabidopsis Information Resource (TAIR) is a database of genetic and molecular data for the model higher plant *Arabidopsis thaliana*, which is used to study properties of all plants. The database includes information about the complete genome sequence, gene structure, metabolism, gene expression, DNA, seed stocks, publications, and more for *Arabidopsis* researchers across the globe. TAIR is located at the Carnegie Institution's Department of Plant Biology in Stanford, CA, and is funded by the National Science Foundation.

InBrief



❶ David Swensen

❷ President Richard Meserve (left) poses with Robert Smolen (middle) of the National Nuclear Security Administration and GL director Russell Hemley (right) at the Stewardship Science Academic Alliances Program Symposium.

Image courtesy Steve Gramsch

❸ Chief Advancement Officer Christine Smith left in May.

Trustees and Administration

❶ Senior trustee **David Swensen**, chief investment officer at Yale U., was elected to the American Academy of Arts and Sciences this spring.

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❷ Carnegie president **Richard A. Meserve** gave the welcoming remarks at the 2008 Stewardship Science Academic Alliances Program Symposium, sponsored by the National Nuclear Security Administration and held Feb. 26-28 at the administration building. He also welcomed the DC Biotech Mentoring Conference, sponsored by CASE, Feb. 28-Mar. 2. On Mar. 13-14 Meserve attended and moderated a session at the National Academies' Summit on America's Energy Future. He introduced Sean Solomon at the BBR Neighborhood Lecture on the MESSENGER flyby on Mar. 25 and chaired the Agenda 2008 Study Group on Presidential Science and Technology Advisory Assets, a project of the Center for the Study of the Presidency, on Mar. 26 and June 13. On Apr. 1 he attended a meeting of the National Commission on Energy Policy. He chaired the IAEA's International Nuclear Safety Group in Vienna, Austria, on Apr. 9-11 and spoke about the revival of nuclear power at the 12th Annual Washington Energy Policy Conference at the Paul H. Nitze School of Advanced International Studies at The Johns Hopkins U. on Apr. 22. He attended and gave a presentation on energy at the Milken Inst. Global Conference in Los Angeles on Apr. 28. Meserve opened the Carnegie New York Symposium at the Harvard Club of New York City on May 20 for a lecture by Sean Solomon. He chaired a meeting of the National Academies Nuclear and Radiation Studies Board May 29-30. On June 2 he and Maxine Singer hosted a dinner to announce the establishment of a Math *for* America program in Washington, DC. On June 26 Meserve talked about international nuclear safety at the Nuclear Plant Safety course at MIT.

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CASE co-director **Julie Edmonds** received a 2007 Distinguished Alumni Award from La Trobe U. in Melbourne, Australia, where she obtained her undergraduate and Master of Science degrees. In Mar. she traveled to Australia for the awards ceremony.

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❸ Chief Advancement Officer **Christine Smith** left Carnegie May 23 to take a position as associate vice president for advancement at Lehigh U. in Bethlehem, PA.

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New arrivals in the administration included **Mulyono Kertajaya**, business data analyst, and **Vinutha Saunshimath**, computer systems associate. CASE welcomed two newcomers, **Juna Wallace**, CASE assistant, and **Yeelan Ku**, CASE associate.

Embryology

Department director **Allan Spradling** was an invited speaker at the Development and Cancer conference in Madrid and at the Institute for Research in Biomedicine in Barcelona. He also spoke at the Harvey Society Lecture Series at Rockefeller U., the 49th Annual Drosophila Research Conference, and the 3rd Annual Wisconsin Stem Cell Symposium. This spring he also gave lectures at Carnegie Mellon U., Emory U., and Harvard U.

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Joseph Gall was an invited speaker at the Howard Hughes Medical Institute workshop on RNA granules and a distinguished lecturer at Fox Chase Cancer Center. He also gave a lecture at Rosalind Franklin U. of Medicine and Science.

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Marnie Halpern was an invited speaker at the UCLA and U. Pennsylvania medical schools.

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Douglas Koshland spoke at U. Texas Southwestern Medical Center in Dallas, Dana Farber Cancer Institute in Boston, and Memorial Sloan Kettering Cancer Center in NY.

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Yixian Zheng spoke at UC-San Francisco, Genentech, Inc., U. Utah Huntsman Cancer Inst., Australian National U. in Canberra, and Peter MacCallum Cancer Centre in Melbourne. She was also an invited speaker at the 8th Hunter Meeting in Australia.

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David MacPherson has received funding awards from the Knights Templar Eye Foundation and from the Pearle Vision Foundation.

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Judith Yanowitz was granted a 5-year Mentored Research Scientist Development Award from NIH. **Jaclyn Lim** of the Yanowitz lab received the 2008 Danny Lee Award from The Johns Hopkins U. This award is presented each year to a graduating senior majoring in the biological sciences in recognition of outstanding promise, talent, motivation, and achievement in scientific research. Jaclyn will pursue graduate studies at Stanford in the fall.

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Elçin Ünal, recent graduate of the Koshland Lab, won the 2008 Harold M. Weintraub Graduate Student Award. The award recognizes outstanding achievement during graduate studies in the biological sciences.

Elçin Ünal, 2008 Weintraub awardee

Image courtesy Christine Pratt

In Jan., Carnegie chairman of the board **Michael Gellert** and president **Richard A. Meserve** led a trip to the Las Campanas Observatory in Chile. The group included Acting Secretary of the Smithsonian Cristián Samper, Ralph Puerta, Griselda Hale, and long-time Carnegie trustee Jaylee Mead. From left to right: Griselda Hale, Arnold Phifer, Mark Phillips, Frank Perez, Wendy Freedman, Richard Meserve, Cristián Samper, Michael Gellert, Jaylee Mead, Christine Smith, and Ralph Puerta.

Image courtesy Griselda Hale

❹ Allan Spradling gives the welcoming remarks at the 2008 minisymposium.

Images courtesy Christine Pratt

❹ Postdocs Dan Gorelick and Mary Goll organized the minisymposium with fellow postdoc Lucy Morris (behind the camera).

Embryology's Bill Kupiec cooks at the departmental barbecue. He and Tom McDonaugh organize it every year.

High school intern **Shauna Linn** in the Halpern lab won the Grand Prize in Biological Sciences at the 2008 Baltimore Science Fair and the Use of Statistical Analysis Award given by the American Society for Quality. In May she presented her work at the Intel International Science Fair in Atlanta, GA.

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❹ "The Biology of Aging" was the title of the department's annual minisymposium in Mar., co-organized by postdocs **Lucy Morris**, **Dan Gorelick**, and **Mary Goll**. Scientists crowded the Rose Auditorium to hear topics ranging from the genetic basis of aging to the role of stem cells in aging.

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Arrivals: Svetlana Deryusheva from the Biological Research Inst. in St. Petersburg, Russia, joined the Gall lab as a visiting scientist. **Ina Soh** joined the Bortvin lab in Jan. and will help with various research projects while finishing her studies in the JHU master's program in molecular and cellular biology. **Julie Gleason** joined the Farber lab in Feb. after receiving her Ph.D. in biological sciences from U. Maryland-Baltimore County. The department also welcomes **Colin Huck** and **Tosa Puvapiromquan** to the animal care facility.

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Lab technician **Tara Hardiman** left the Bortvin lab in June for graduate studies at JHU Bloomberg School of Public Health.

Geophysical Laboratory

In Feb. GL director Russell Hemley gave an invited Sigma Xi lecture, "Diamond Windows on Extreme Conditions," at NIST in Gaithersburg, MD. Also in Feb. he gave an invited talk at the 2008 Stewardship Science Academic Alliances (SSAA) Program Symposium in Washington, DC. In Mar. he chaired a town hall meeting on Materials Physics at Gigabar Pressures at the American Physical Society's meeting in New Orleans. He gave an invited talk at the US Army Research Laboratory in Aberdeen, MD, in Apr.

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Director Emeritus **Wes Huntress** was a keynote speaker at the 50th anniversary celebration of the launch of America's first satellite, *Explorer 1*, at JPL in Jan. He organized a workshop on the future of space exploration held at Stanford U. in Feb. He gave an invited talk on the same subject at the Goddard Memorial Symposium in Greenbelt, MD, in Mar.

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Staff scientist **Ho-kwang Mao** delivered the Smith Lecture on "Diamond Windows on Planetary Interior—Minerals & Rocks" in Mar. at the Dept. of Geological Sciences, U. Michigan, in Ann Arbor.

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Staff scientist **Robert Hazen** spoke on mineral evolution at NASA Goddard Space Flight Center, the US Naval Observatory, and the Astrobiology Science Conference (AbSciCon) in Santa Clara, CA. He was a featured commentator on National Geographic Television's *Origins* series and on *EcoViews* (Maryland Public Television). The new mineral "hazenite," a phosphate biomineral discovered at Mono Lake, CA, by former GL postdoc Hexiong Yang (now at U. Arizona), was named in his honor.

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Staff scientist **Bjørn Mysen** presented an invited lecture at a symposium titled "Origin, Evolution, and Dynamics of the Earth" at the Inst. for Study of the Earth's Interior in Misasa, Japan, in Mar.

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Staff scientist **George Cody** presented an invited talk at the International Astronomical Union meeting titled "Organics in Space" at Hong Kong U. in Feb. In Mar. he gave an invited talk at the Inst. for Study of the Earth's Interior, Misasa, Japan, and also spoke at The Johns Hopkins U. In Apr. he gave a seminar at UC-Berkeley.

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Staff scientist **Ronald Cohen** organized and ran a workshop titled "Fundamental Physics of Ferroelectrics, 2008" in Williamsburg, VA, in Feb. This workshop has been running annually since 1990. About 95 participants discussed theory and experiments on ferroelectric materials.

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Nabil Boctor attended the European Geosciences Union meeting in Vienna, Austria, and presented a paper on volatile abundances and hydrogen isotope signatures in Martian meteorites.

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James Cleaves was elected chairman of the 2012 Gordon Research Conference on the Origin of Life. He gave talks at AbSciCon in Santa Clara, CA. He spoke on "The Origin of Biomolecules" at the 235th ACS National Meeting in New Orleans, LA, and on "Organic Synthesis from Neutral Atmospheres Reconsidered" at the Gordon Research Conference on the Origins of Life in Ventura, CA.

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Postdoctoral associate **Hikaru Yabuta** gave presentations at the 39th Lunar and Planetary Science Conference in League City, TX, in Mar. and at AbSciCon in Santa Clara, CA, in Apr. Yabuta is now an assistant professor at the Dept. of Earth and Space Science, Osaka U., Japan, after three years of postdoctoral research with George Cody and Conel Alexander at Carnegie.

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On Apr. 4 the GL dedicated its new conference room in honor of the late Francis R. (Joe) Boyd. Among Boyd's many accomplishments was his co-invention of the piston-cylinder apparatus, a high-pressure device used throughout the world. He was on the GL staff for over 50 years. The new Boyd Conference Room is used for many CDAC activities.

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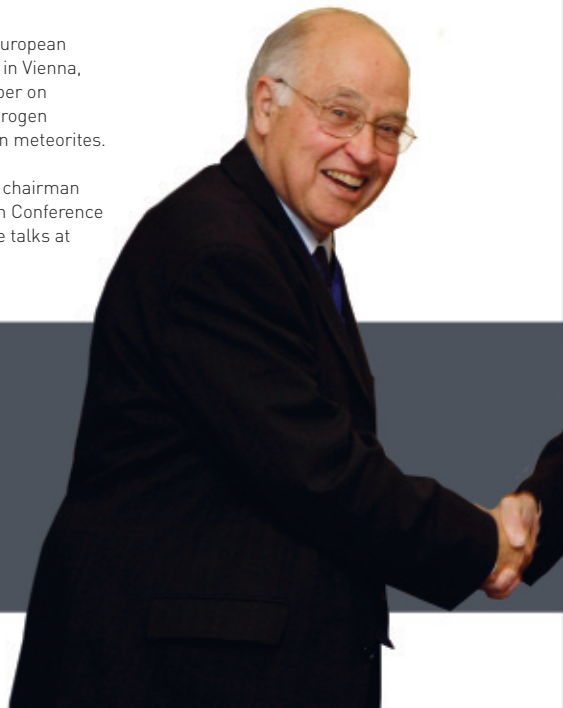
For the second year in a row, Carnegie hosted the annual SSAA Program Symposium at its historic administration building in downtown Washington, DC. The meeting was held Feb. 26-28 and drew participants from around the country. Individual grant recipients and center directors from the program's three divisions (High-Energy-Density Physics, Low-Energy Nuclear Science, and Materials Properties Under Extreme Conditions) gave updates on center or group activities and progress. GL and CDAC director Russell Hemley gave an overview of the program in his invited talk.

Director Russell Hemley was elected in Mar. to Corresponding Fellowship of the Royal Society of Edinburgh—Scotland's national academy of science and letters.



Russell Hemley (right) with Sir Michael Atiyah, president of the Royal Society of Edinburgh

Image courtesy Russell Hemley

❺ Cristina Archer
Image courtesy Cristina Archer

Global Ecology

In Jan. lab director **Chris Field** gave a public talk at Stanford, "IPCC, Kyoto and the Next Steps to Meet the Challenge of Climate Change." In Mar. he joined a panel discussion celebrating the 5th anniversary of the Stanford Global Climate & Energy Project. In Apr. he attended the IPCC plenary meeting in Budapest.
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Ken Caldeira gave a talk in Jan. at Google on geoengineering, now posted on YouTube. Also in Jan. he spoke on ocean acidification and geoengineering as part of the Energy Seminar series at Stanford. On Jan. 18 he was filmed at the Fitzgerald Marine Reserve near Half Moon Bay, CA, for a documentary on ocean acidification. In Feb. he participated in a panel at the Commonwealth Club in San Francisco; the discussion of the next steps in greenhouse gas emissions control was broadcast on public radio on Mar. 7. On Feb. 22 he gave a short talk to a group of about 100 cabinet-level ministers and their senior aides at a side event of the United Nations Environment Programme meeting in Monaco. In Mar. he attended a meeting of the Hawaii Conservation Alliance at U. Hawaii-Manoa. His presentation was shown on the evening television news, creating much interest. In Apr. he gave a keynote speech at the European Geophysical Union annual meeting in Vienna, Austria.
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Greg Asner and his entire lab are in Kruger National Park this spring, conducting studies on adaptive management, especially issues connected to the sustainable management of elephants, in collaboration with park staff and other South African scientists.
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❺ Research associate **Cristina Archer** attended the 88th Annual Meeting of the American Meteorological Society in New Orleans in Jan. where she presented a paper, coauthored with **Ken Caldeira**, on trends of intensity, latitude, and altitude of the jet streams in recent decades.
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Field lab postdoc **Noel Gurwick** attended an NSF riparian zone workshop titled, "Generalizing Riparian Zone Function at the Landscape Scale: New Tools, New Approaches, Gaps in Knowledge and Future Research Directions," held in Indianapolis Jan. 27-30.

Former postdoc **Ulli Seibt** visited GE again for several months and worked with **Joe Berry** on modeling chemical cycles (e.g., carbonyl sulfide).
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Claudia Tebaldi is visiting from Climate Central, an emerging nonprofit organization based in Princeton, NJ, with new offices opening in Palo Alto, CA. Their mission is the communication of science findings and solutions regarding climate change.
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Eben Broadbent, a graduate student in the Asner lab, won a Global Change Education Program Graduate Research Environmental Fellowship. He will investigate how forest architecture interacts with climate changes to influence carbon dynamics in a Hawaiian rain forest.
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Arrivals: The Asner lab welcomed two new members: **Ruth Emerson** arrived Jan. 21 from Stanford U. and research technician **James Jacobson** arrived Feb. 19 from UC-Santa Cruz. The Berry lab welcomed former postdoctoral research associate **Miguel Ribas-Carbo** from Universitat de les Illes Balears, Spain, as a visiting researcher on Mar. 4. **Douglas MacMynowski**, a senior research fellow in Control and Dynamical Systems at Caltech, is working primarily with Ken Caldeira to understand the dynamics of phenomena such as the North Atlantic meridional ocean overturning circulation and El Niño. Intern **Angela Torney** joined the Field lab on Jan. 2.
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Departures: Postdoctoral research associate **Maoyi Huang** left the Asner lab on Mar. 15 for New York, and lab technician **Paulo Oliveira** left on Mar. 31 to pursue his Ph.D. at ETH Zürich.

Observatories

In Feb. director **Wendy Freedman** attended an Astronomy and Astrophysics Advisory Committee (AAAC) meeting in Washington, DC. She gave talks on the Carnegie Supernova Project at the UCLA Dark Matter meeting in Feb. and at the CIFAR08/Linde Fest, Stanford U., in Mar. Also in Mar. she gave a talk at Sewanee U. in TN. In Apr. she spoke at the Giant Magellan Telescope event hosted by George Mitchell in Houston, TX; gave the Carnegie lecture "Einstein's Biggest Blunder?" at Skirball Cultural Center, Los Angeles, CA; and attended the annual NAS Meeting in Washington, DC.
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Staff astronomer **Luis Ho** gave colloquia at the Center for Astrophysics, Guangzhou U.; Kavli Inst. for Astronomy and Astrophysics, Peking U.; Beijing Astronomical Observatory; U. Hong Kong; Purple Mountain Observatory and Nanjing U. in Nanjing, China; Kavli Inst. for Particle Astrophysics and Cosmology at Stanford, CA; and U. Virginia. He also gave an invited talk at the Yukawa Inst. for Theoretical Physics, Kyoto U., in a workshop titled "Accretion and Outflow in Astrophysics." He traveled to Green Bank, WV, to serve on the NRAO Users Committee.
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Masami Ouchi, Carnegie Fellow, received the ASJ Young Astronomer Award for his exceptional work in studies of galaxy structure and formation. He gave an award lecture on Mar. 26 at the 2008 spring meeting of the Astronomical Society of Japan in Tokyo. In Apr. he gave an invited talk at a workshop in Dunk Island, Australia, and gave a colloquium at Swinburne U., Melbourne.
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Inese Ivans, Carnegie Princeton Fellow, gave talks at the following meetings: the 5th Russbach Workshop on Nuclear Astrophysics in Austria, the 14th Ringberg Workshop on Nuclear Astrophysics in Germany, and a Mini r-process Workshop at U. Chicago.
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Spitzer Fellow **Jane Rigby** gave an invited colloquium at Harvard U. in Feb. In Apr. she spoke on Compton-thick AGN at the annual High Energy Astrophysics Division meeting in Los Angeles, CA.
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Claudia Maraston, senior lecturer at U. Portsmouth, UK, visited the Observatories for two weeks in May and presented a colloquium titled "Stellar Population Models."

Plant Biology

Acting director **Wolf Frommer** presented seminars at U. Texas Southwestern on Mar. 4 and at the Molecular and Environmental Plant Sciences Symposium at Texas A&M on Mar. 5. He gave a talk in Cologne, Germany, on Apr. 11.
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On Mar. 6 **Winslow Briggs** presented a seminar at UC-San Diego about the phototropin LOV domain. In Apr. he chaired a review committee for the U. Massachusetts graduate program in plant biology.
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Kathryn Barton presented a lecture in Jan. at UCLA, "Unzipping Leaf Development: How LITTLE ZIPPER Proteins Function in Polar Leaf Development."
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In Feb. **Zhi-Yong Wang** presented a talk, "Proteomic and Genomic Dissection of the Brassinosteroid Signaling Pathway," at U. Minnesota. He presented related talks in Apr. at Hebei Normal U., China; the Chinese Academy of Agricultural Sciences, Inst. of Crop Sciences, Beijing; and U. Maryland Biotechnology Inst., Rockville, MD. Also in Feb. Wang attended the Keystone Symposium on Plant Hormones and Signaling in Keystone, CO, and spoke at the Gordon Research Conference on the Biology of 14-3-3 Proteins in Ventura, CA.
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INSIDE HUNGER

Kathryn Barton taught a fall seminar at Stanford, where eighteen freshmen explored the science behind one of the most primitive biological experiences: sensing and responding to hunger. They approached the issue from many vantages and examined starvation responses in organisms ranging from bacteria and worms to bears and humans. Examples of questions students addressed are: What signals and receptors inform the individual that it is sated or hungry? What is known about the biology and genetics of human appetite and energy-storage diseases such as obesity, anorexia, and diabetes? What is the effect of chronic hunger on children's developing brains? What happens when a mammal hibernates? How good is the evidence for caloric restriction in promoting longevity?

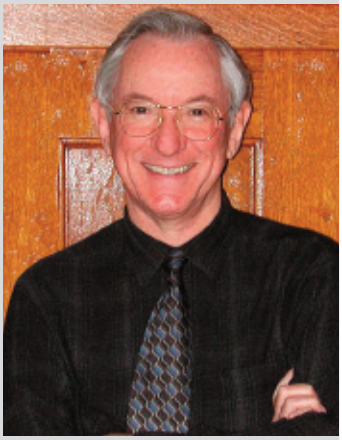
Students also learned about the identification of vitamins in the early 19th and 20th centuries, which abated widespread vitamin deficiencies. They studied catastrophic famines and their causes, including a look at the fungus *Phytophthora infestans*, which caused the great potato famine in Ireland. They also looked at the relationship between agriculture and hunger, whether there is a role for recombinant DNA technology in improving the nutritional quality of food, and whether we can predict the effects of climate change on world hunger patterns. The course ended with a student-made meal—using local ingredients—eaten during the presentation of students' final projects.

The Plant Biology lunchroom was used to make the end-of-class meal. Ingrid Inema (left) and Charity Capelo helped out. Ingrid is from Rwanda and has experienced severe hunger firsthand.

These M&M's candies were used as props to demonstrate the efficiency of hunting and gathering versus agricultural food production. The two Stanford freshmen are Margot Hedlin (left) and Donnell Van Noppen.

Images courtesy Kathryn Barton

Plant biologist Kathryn Barton



❻ Terrestrial Magnetism director Sean Solomon

Devaki Bhaya co-organized the Cyanobacteria in a Lunar Environment workshop held at NASA Ames, Jan. 28-30. The workshop brought together about 50 scientists, including microbiologists, planetary scientists, and experts in flight experiments and hardware, to assess the effects of the space environment on cyanobacteria. **Arthur Grossman** presented the workshop overview.

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Postdoctoral associates from the Departments of Plant Biology and Global Ecology hosted three joint fall and winter seminars. **Meghan Sharp** (Barton lab) and **Roland Pieruschka** (Berry lab) organized the series. David Zilberman (UC-Berkeley) presented a talk on "The Intersection of Energy and Agriculture: Biofuel and New Technology." Jonathan Foley (U. Wisconsin-Madison) followed with a lecture titled "Against the Grain: The Influence of Changing Agricultural Management on the Earth System." Ian Baldwin (Max Planck Inst. for Chemical Ecology) finished the series with a presentation on Using Native Habitats to Understand Gene Function.

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Arrivals: The Frommer lab welcomed **Ben Becker** and **Alex Pauck** from Universität Bonn, Germany, in Jan. and **Jennifer Ewald** from ETH Zürich in Feb. Postdoctoral research assistant **Enrico Magnani** arrived from UC-Berkeley to join the Barton lab on Feb. 1. Two visitors to the Wang lab, **Hui Yang** from Gansu Academy of Sciences, China, and **Shuqing Zhao** from Shanxi U., China, arrived in Mar. The Rhee group welcomed three new arrivals. Research assistant **Bindu Ambaru** started in Mar., and programmer **Aung-Kyaw Chi** arrived from Cold Spring Harbor Laboratory in Jan. Curator **A. S. Karthikeyan** came from Purdue U.

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Departures: Postdoctoral research associates **José Estevez**, **Ying Gu**, **Kian Hematy**, **Shundai Li**, and **William Underwood** left for Chris and Shauna Somerville's new labs at UC-Berkeley on Jan. 31. Postdoctoral research associate **Melisa Lim** left the Shauna Somerville lab in Mar. for the United Nations in Vienna, Austria. In Jan. postdoctoral research associate **Dominique Loque** left the Frommer lab to be director of the Feedstocks Division at LBNL, UC-Berkeley. **Totte Niittylä** left that lab in Mar. for the Umeå Plant Science Centre, Sweden. Postdoc **Ozgur Ozturk** left the Rhee lab in Mar. for AdMob in San Mateo, CA, and assistant curator **Suzanne Fleshman** left in Feb. for Hawaii. In Apr. **Nakako Shibagaki** left the Grossman lab for the Joint BioEnergy Inst. in Berkeley.

Department of Terrestrial Magnetism

❻ **Sean Solomon** chaired a meeting of the MESSENGER Science Team in Santa Barbara in Feb. and a meeting of the NASA Advisory Council's Planetary Science Subcommittee at the BBR campus in Mar. In Apr. he spoke about MESSENGER's Jan. Mercury flyby results, as the first annual Bradley Lecturer of the Geological Society of Washington and as a Frontiers in Astrophysics Lecturer at the Hayden Planetarium in Apr. He also spoke about the results in seminars at U. Alberta and U. Colorado that month and at U. Wisconsin and the Geophysical Laboratory in May. Also in May, Solomon co-convened a special session on the MESSENGER flyby at the AGU Joint Assembly in Fort Lauderdale, FL.

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In Feb. **Alan Boss** was filmed at DTM by National Geographic Television for a documentary on extrasolar planets.

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Paul Butler had observing runs in Feb. at Carnegie's Magellan Clay telescope and the Keck Observatory and in Mar. at the Anglo-Australian Observatory. He delivered a seminar on extrasolar planets at MIT in May.

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❼ Carnegie astronomer Vera Rubin

❽ Maureen Long

In May, **John Chambers** gave a talk on extrasolar planets at the American Astronomical Society Division on Dynamical Astronomy 2008 meeting in Boulder, CO.

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Larry Nittler delivered an invited talk at the International Astronomical Union Symposium 251, Organic Matter in Space, in Hong Kong in Feb.

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❼ The 2008 Richtmyer Memorial Award was presented to **Vera Rubin** by the American Association of Physics Teachers at their 2008 winter meeting in Baltimore in Jan. In Mar., on her receipt of the 2008 Cosmos Club Award in Washington, DC, she gave a talk on dark matter and women in astronomy. Rubin was featured in *Discover* magazine's spring 2008 issue.

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In Mar. **Scott Sheppard** presented a summary of research on objects in the outer Solar System at the New Horizons mission science team meeting in Boulder, CO.

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Paul Silver taught a class and gave a lecture at MIT in Apr. In May he gave colloquia at the 2008 Bi-Lateral Workshop Under the Sino-US Earthquake Studies Protocol in Boulder, CO.

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Postdoctoral fellow **Alceste Bonanos** gave a talk on massive stars at UC-Santa Barbara in Feb.

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❽ Postdoctoral associate **Maureen Long** spoke about subduction zones and seismic anisotropy at U. Maryland in Feb. and at Princeton in Mar.

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Postdoctoral fellow **Mercedes López-Morales** gave talks on the search for extrasolar planets at the Physics Diversity Summit and the 2008 Joint Annual Conference of the National Society of Black Physicists and the National Society of Hispanic Physicists in Washington, DC, in Feb. In Mar. she spoke about the search for Earth-mass planets at the 2008 Hubble Fellows Symposium in Baltimore. In Apr. López-Morales gave invited talks in Spain, at the Laboratory for Space Astrophysics and Fundamental Physics in Madrid, the U. Santiago Astronomical Observatory in Santiago, and the Institut de Ciències de L'Espai in Barcelona.

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Postdoctoral fellow **Isamu Matsuyama** gave a colloquium at the 2008 Les Houches School in Les Houches, France, in Feb.

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In Feb. postdoctoral fellow **Ann Nguyen** gave talks at the 2008 International NanoSIMS Workshop in Perth, Australia. She gave an invited talk at the Smithsonian National Museum of Natural History in May.

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Postdoctoral fellow **Matt Schrenk** spoke at the Dark Energy Biosphere Institute Workshop hosted by U. Southern California on Catalina Island, CA, in Feb. In Apr. he gave an invited talk on deep-sea hydrothermal deposits at U. Illinois-Chicago.

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Postdoctoral fellow **Jessica Warren** gave colloquia on the Earth's mantle at the Geological Society of Washington, the 3rd COE-21 International Symposium in Misasa, Japan, and U. Maryland in Feb., Mar., and Apr., respectively.

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The 39th Lunar and Planetary Science Conference was held in League City, TX, in Mar. Presenters included **Sean Solomon**, **Conel Alexander**, **Alan Boss**, and **Larry Nittler**; postdoctoral fellows **Ann Nguyen**, **Liping Qin**, and **Thomas Ruedas**; ion microprobe research specialist **Jianhua Wang**; and visiting investigator **Sergei Ipatov**.

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Alan Linde hosted a meeting of the Caribbean Andesite Lava Island Precision Seismo-geodetic Observatory project, held on the BBR campus in Mar., and gave colloquia, along with **Selwyn Sacks** and **David James**.

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Rick Carlson and **David James** hosted the annual workshop of the High Lava Plains Seismic Experiment on the BBR campus in Apr. Participants included postdoctoral associate **Maureen Long**, former postdoctoral fellow **Catherine Cooper**, field seismologist **Steven Golden**, and visiting investigator **Matt Fouch**.

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Alan Boss and postdoctoral fellow **Matt Schrenk** gave talks at the Astrobiology Science Conference (AbSciCon) in Santa Clara, CA, in Apr. Also at AbSciCon, Boss cochaired the first meeting of the NASA Astrobiology Institute's new Planetary System Formation Focus Group.

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Gregory Beroza of Stanford U. delivered the first Brinson Lecture on the BBR campus in Apr. Sponsored by the Brinson Foundation, the lectures are intended to highlight innovative work in the field of earthquake seismology and to provide opportunities for collaborations between speakers and DTM scientists on novel measurements of earthquake phenomena.

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Matt Schrenk, formerly of GL, joined DTM as a postdoctoral fellow in Feb.

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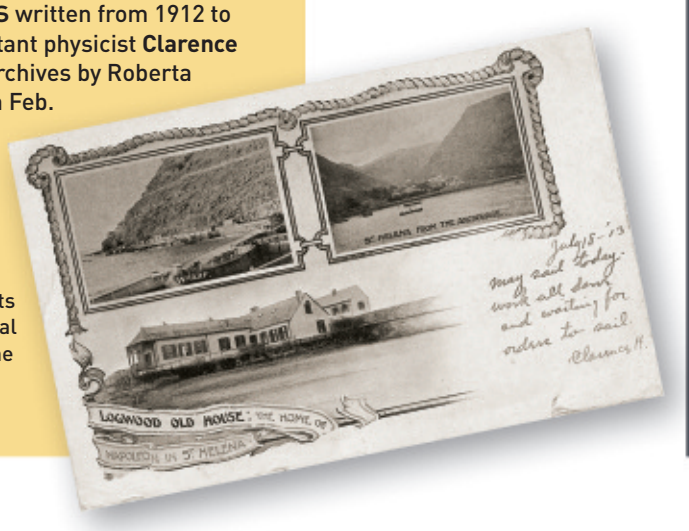
Administrative assistant **Michelle Martin** departed DTM in Apr. Postdoctoral fellow **Fred Ciesla** departed DTM in May to begin a position as an assistant professor in the Dept. of Geophysical Sciences at U. Chicago. □

A series of letters and postcards written from 1912 to 1914 by DTM magnetic observer and assistant physicist **Clarence Wilson Hewlett** was donated to the DTM Archives by Roberta Cooke Gibson of Manchester Center, VT, in Feb.

The letters discuss Hewlett's experiences on the research vessel *Carnegie* and his move into the "new laboratory" at DTM—the Abelson Building—which is now the oldest building on the BBR campus.



A postcard from the Hewlett archives documents one stop made by Clarence Hewlett, a Terrestrial Magnetism magnetic observer who sailed on the ship *Carnegie*.

Nelson McWhorter, DTM's senior instrument maker and shop manager, passed away on Saturday Apr. 12, 2008, at his home in Alexandria. A funeral service was held on Apr. 18 at the Bush Hill Presbyterian Church in Alexandria. A skilled instrument maker and key contributor to many of the department's laboratory and field efforts, McWhorter had been a member of the DTM staff since 1985. He leaves an entire campus of friends and will be missed.

Nelson McWhorter (above)

Carnegie Institution in Top 1% of Charities for Best Fiscal Management

Charity Navigator, America's largest charity evaluator, has awarded the Carnegie Institution its highest rating, four stars, for sound fiscal management for seven years running. The organization evaluates over 5,300 charities, and only 12 have received a four-star rating seven years in a row. Receiving the top-star rating indicates that Carnegie excels, compared with other charities in the United States, in successful financial management.

Charity Navigator's letter stated: "We are proud to announce [the] Carnegie Institution of Washington has earned our seventh consecutive 4-star rating for its ability to efficiently manage and grow its finances. . . . This 'exceptional' designation from Charity Navigator differentiates [the] Carnegie Institution of Washington from its peers and demonstrates to the public it is worthy of their trust."

Charity Navigator bases its analyses on the financial information each charity provides annually in "its informational tax returns, or IRS Forms 990." During the last year, 85.9% of Carnegie expenses went toward scientific programs, while 13.9% was expended for administrative and fund-raising purposes.

"Andrew Carnegie would be pleased to know how carefully we are managing the institution's funds," commented Carnegie president Richard Meserve. "His goal was to keep administrative costs low so that we can support the high-risk, high-reward scientific research for which the institution has become known. This record demonstrates that the legacy continues." □

For more information about Charity Navigator's evaluation, see http://www.charitynavigator.org/index.cfm?bay=search.summary&orgid=3424.

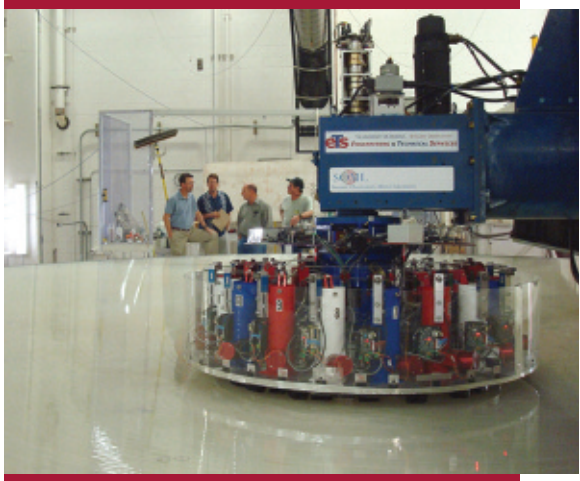


Image courtesy University of Arizona Mirror Laboratory

Giant Magellan Telescope Progresses

The first GMT off-axis 8.4-meter primary mirror segment has entered the "grind and polish" phase. When polishing is complete, the surface accuracy will be on the order of ±15-20 nanometers. That means if the mirror were the size of the continental United States, the largest "hill" on the mirror surface would be about ¼ inch high!

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