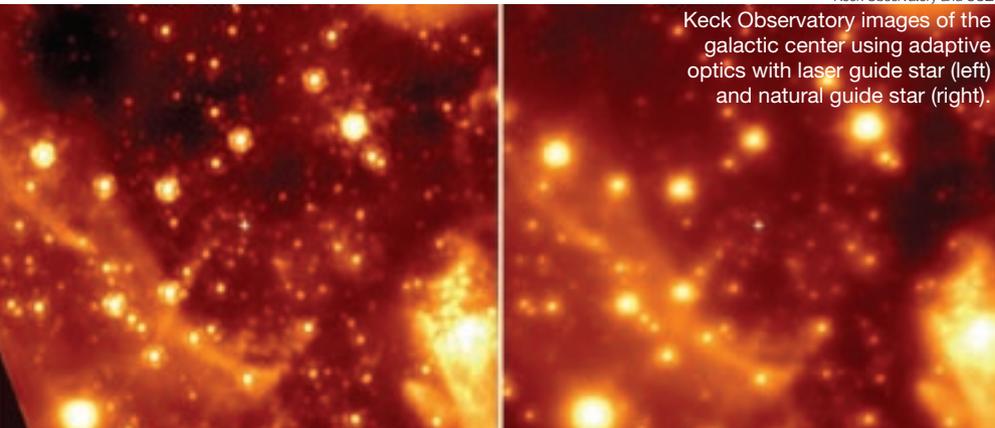


Keck Observatory and UCLA

Keck Observatory images of the galactic center using adaptive optics with laser guide star (left) and natural guide star (right).



Lasers Guide Astronomers to Detailed Discoveries

After one year of operation, a laser-guided adaptive optics system has sharpened astronomers' vision of the center of our galaxy and detected several faint—and mysterious—objects.

At the January meeting of the American Astronomical Society in Washington, D.C., researchers shared what they found using the laser-guide-star system, including three new moons in the outer fringes of the solar system and a pair of dissimilar failed stars.

The adaptive optics system, installed on one of the two 10-m telescopes at the W.M. Keck Observatory in Hawaii, uses a dye laser to create an artificial “star” by exciting mesospheric sodium atoms some 90 km above the ground. The false star

is too faint to be seen by the naked eye, but it's plenty bright enough for one of Earth's biggest telescopes.

Lick Observatory in California had the first true sodium laser guide star (OPN, April 2004, p. 9), but the Lick telescope has only a 3-m aperture and is no longer on astronomy's cutting edge. The Keck has more than 10 times the light-gathering power.

Previous adaptive optics systems relied on a bright star in the telescope's field of view as a reference for subtracting the blurring effects of Earth's atmosphere from astronomical images. Not all interesting objects in the universe happen to be located near a bright star from Earth's perspective, though.

Keck's laser-guide-star system can apply adaptive corrections to 50 times more sky area than the previous natural-guide-star system, and at some wavelengths the new images are even sharper than those from the Hubble Space Telescope, which flies above Earth's atmosphere.

Astronomer Antonin Bouchez of the California Institute of Technology and his colleagues used the Keck system to discover three moons orbiting other objects in the Kuiper Belt, a region of numerous small bodies on the edge of the solar system. These satellites probably formed from debris from giant impacts early in the history of the solar system. Laser guide stars offer the only hope of studying these moons in more detail in the future.

Michael Liu, a University of Hawaii astronomer, used the Keck system to image a strange new pair of twin “brown dwarfs”—gassy objects that don't contain enough mass to sustain nuclear fusion. Laser guide stars are crucial to finding binary brown dwarfs because the angular distance between such pairs is very small.

Observations of the newly discovered twins in three infrared bands revealed that they have different colors. Liu's team thinks that the redder object has opaque iron clouds in its atmosphere, while any such clouds in the bluer dwarf's atmosphere are either thinning or breaking up. These observations imply that small differences in temperature may affect the structure of brown dwarfs in big ways.

Jessica R. Lu, a graduate student at the University of California Los Angeles, said the laser-guide-star technology has enabled the first determinations of the orbits of massive young stars located close to the massive black hole at the center of the Milky Way.

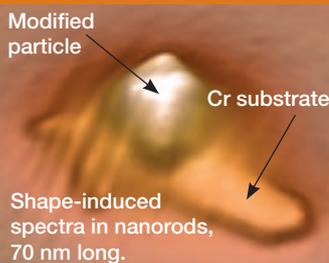
Laser-guide-star systems are in the works for other large observatories, including the other 10-m Keck telescope and the multinational Gemini North 8-m telescope in Hawaii. Gemini North will use a solid-state laser, which will be easier to maintain than the dye laser, said Keck staff astronomer David Le Mignant.

— Patricia Daukantas

Did You Know?

On the nanoscale, gold may shine in a different way than it does in macroscopic jewelry. In a study of tiny gold rods 20 nm wide and up to 300 nm long, U.S. and French researchers who study photoluminescence found that they can control the wavelength of the light emitted by the tiny rods (Phys. Rev. Lett. **95**, 267405) when the rods are placed in the beam of an ultrafast Ti:sapphire laser.

According to group leader Gary Wiederrecht of Argonne National Laboratory, the experiment backs up previous suggestions that the emission from the rods results from the radiative decay of surface plasmon resonances. Although the nanoscale rods have lower photoluminescence efficiencies than quantum dots, they could still find a use in future sensor technology.



Shedding Light on Microstrokes

Microstrokes, or infarctions that kill off only small bits of brain tissue, are a likely cause of dementia and cognitive decline in elderly people. By manipulating cortical blood flow in rat brains, a team of physicists and neuroscientists has gained new insight into the redundancy of the brain's vascular network.

Like humans, rats have a highly interconnected network of small arteries feeding the cortex, or the outermost layer of brain tissue. The researchers, based at the University of California San Diego (UCSD), used a laser-induced clotting technique to block one tiny blood vessel in each rat cortex (Public Library of Science Biology 4(2), e43). The photothrombosis technique stops the blood flow in a small artery without setting up a shock wave that would damage neighboring blood vessels by itself.

After causing the arterial blockage, the team used two-photon laser scanning microscopy to map the changes in the diameters of the blood vessels near

the blockage and the speed of the blood flow in these vessels. UCSD biophysicist David Kleinfeld, Winfried Denk of the Max Planck Institute for Medical Research in Germany, and two other colleagues adapted this flow-scanning technique to trace the movements of individual red blood cells. Because of the redundant connections in the vascular network, the blood flow in the rat brains was reversed and redirected around the locations of the artificial microstrokes.

According to Kleinfeld, the UCSD team's results echo the findings from a Dutch study that used cerebral magnetic resonance imaging to study the incidence of small infarctions and lesions among elderly people. That study

had found that relatively few of these infarctions occurred near the surface of the brain, where the arterial blood supply is most redundant. The UCSD team concluded that their results "suggest an emerging relation between vascular topology and susceptibility to stroke in different regions of the brain."



The cortex of a rat's brain is fed by a complex network of arteries.



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