Astronomy

Our atmospheric moon

New observations reveal that the moon's tenuous atmosphere extends twice as far above the lunar surface as previous observations had shown. The new images, taken during a lunar eclipse, also suggest that sunlight striking the moon probably generates its thin atmosphere.

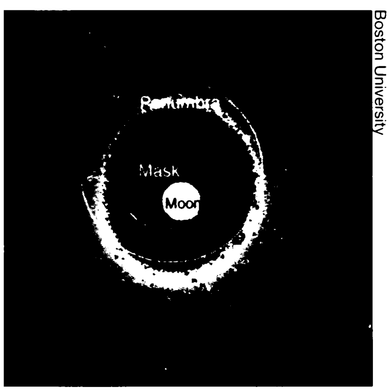
Michael Mendillo and Jeffrey Baumgardner of Boston University reported their findings in the Oct. 5 NATURE and provided further details later that month, at the annual meeting of the American Astronomical Society's Division for Planetary Sciences in Kohala Coast, Hawaii.

During a total lunar eclipse, Earth blocks sunlight from reaching the lunar disk, eliminating the glare that usually arises as moonlight scatters in Earth's atmosphere. Mendillo and Baumgardner detected the faint glow of sodium atoms in the moon's atmosphere beyond the shadow cast by Earth.

"We were surprised to find that this glow extended to over nine times the radius of the moon, to a height of about 14,000 kilometers," says Mendillo. "This is nearly twice the size of the lunar atmosphere as recorded in earlier observations that we had conducted at quarter-moon phase." The researchers observed the moon with a small telescope at McDonald Observatory in Fort Davis, Texas.

Astronomers have suggested three sources of energy that might loosen sodium atoms from the moon's surface and generate the atmosphere: micrometeorites, charged particles of the solar wind, or sunlight.

A uniform distribution of micrometeorites would generate a highly uniform atmosphere, not the irregular geometry that's observed, Mendillo notes. If the solar wind were the source, he adds, the atmosphere shouldn't have been visible when the moon was full and was shielded from the sun's stream of charged particles by Earth's magnetic field. These arguments leave sunlight as the most likely explanation. The researchers note that sunlight may also account for the thin atmosphere observed around Mercury and some asteroids.



Boston University

The eclipsed moon shows the glow of sodium atoms in its atmosphere. Red depicts the highest light intensity, blue the lowest. A mask in the telescope helps block out any moonlight.

Future visit to a comet

Comet Wild-2 has spent most of its life in the deep freeze of the outer solar system. But 2 decades ago, Jupiter's gravity brought the comet in from the cold. In late November, NASA approved plans for a flyby to this pristine emigré from the solar system's outer reaches.

Five years after a launch in 1999, the Stardust spacecraft is scheduled to fly past Wild-2, passing slowly enough to collect samples from the comet's dusty shroud. The craft will venture within 100 kilometers to image the comet's icy nucleus. The pictures are expected to be 10 times sharper than those of Halley, the only other comet that has been photographed close-up.

Although scientists plan to analyze the dust in greater detail when Stardust's return capsule parachutes to Earth in 2006, the craft carries a mass spectrometer to identify composition. Stardust is the fourth in a series of low-cost NASA missions called the Discovery program. The first two, a visit to a near-Earth asteroid and a return trip to Mars, are scheduled to fly next year. A third is to explore the moon in 1997 (SN : 3/11/95, p.157).

Materials Science

Richard Lipkin reports from Boston at a meeting of the Materials Research Society

Watching fractures form

Snaking and branching through a concrete pillar, a bridge support, or a window, cracks follow fascinating paths. Often invisible when they form, cracks typically appear in materials under tension or stress.

To understand more fully the progress of cracks through crystalline materials, Brad L. Holian, a physicist at Los Alamos (N.M.) National Laboratory and his colleagues have developed a computer model—called SPASM—that simulates cracks moving in two and three dimensions.

The work aims to connect mathematical theories of crack propagation with empirical evidence obtained from laboratory studies, Holian says. "The simulations let you see what's happening when something cracks, which is virtually impossible to do at the atomic level in real materials. With the computer, though, you can watch cracks form and spread in a realistic way."

By running simulations on a high-powered computer for 2 to 3 days, Holian's team can track the behavior of many millions of atoms in a crystal under stress. "Six years ago, we could only follow about 15,000 atoms in two dimensions. Now we're modeling 100 million atoms in three dimensions for 10,000 time steps, which add up to about one-tenth of a billionth of a second."

Soon, Holian's team expects to track 1 billion atoms for one-billionth of a second.

Results from simulated experiments support the theory that cracks tend to accelerate quickly before reaching a steady velocity. The moving crack releases energy as sound waves. Branching tends to arise as atoms dislocate along a plane.

"These models should help us either to confirm or overturn theoretical notions about how cracks propagate," Holian says. "Then we'll be in a much better position to design materials at the atomic level specifically to prevent cracking."

Itty-bitty carbon rods

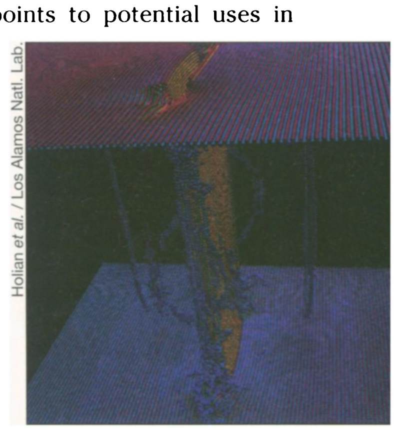
Among materials scientists, the watchword is "nano"—the Greek prefix meaning one-billionth. They're chatting about nanowires, nanotubes, nanospheres. . . and now nanorods.

Charles M. Lieber, a chemist at Harvard University, and his colleagues are cooking up batches of rods that measure only 2 to 30 nanometers across and 1 micrometer long. The rods are composed of carbon in combination with various other elements, such as silicon and tin.

So far, the chemists have fabricated a "large family of chemically distinct, carbide nanorods." By changing the brewing broths and growth conditions, Lieber's team can concoct helical and sawtooth shapes, which he believes may have interesting applications.

Like what? For starters, he points to potential uses in investigating quantum physics and in building more complex nanostructures. Sending electricity through helical rods could create a tiny "rotating magnetic field," which researchers might use for sensing or manipulating atoms.

The little carbon spindles might also come in handy to reinforce alloys or ceramics, says Lieber, and perhaps even to improve high-temperature superconductors.



Holian *et al.* / Los Alamos Natl. Lab.

A simulated fracture in copper.