Astronomers find abundant nitrogen on Pluto

Astronomers for the first time have detected nitrogen and carbon monoxide ice on Pluto. Moreover, the findings indicate that nitrogen is the most abundant material on the planet's frozen landscape, making up about 97 percent of its surface. Carbon monoxide ice accounts for about 1 to 2 percent of Pluto's surface, and it now appears that methane – the only material previously detected on Pluto – has roughly the same low abundance.

"Planetary scientists were uncertain about which was the most abundant ice on Pluto – methane or nitrogen," says Richard P. Binzel of the Massachusetts Institute of Technology. "Now that we know it's nitrogen, we can move forward to understanding more about the planet."

Given that other bodies in the solar system, such as Neptune's satellite Triton, contain nitrogen, the new findings were not unexpected, notes study collaborator Tobias C. Owen of the University of Hawaii in Honolulu. But he says the results are intriguing because Pluto has remained virtually unchanged since its formation several billion years ago.

Thus, Owen says, the mixture of compounds on the planet's surface offers a peek at the chemistry of the very early solar system. In particular, since astronomers believe that comets transported material from the outskirts of the solar system to the inner planets, the composition of distant Pluto may indicate the composition of the early Earth's atmosphere (SN: 9/5/92, p.150).

Before the current study, conducted in May using the United Kingdom Infrared Telescope atop Hawaii's Mauna Kea, astronomers had direct evidence only of methane ice on Pluto, based on that compound's telltale absorption of infrared light. Researchers suspected that molecular nitrogen and carbon monoxide also existed on the surface, but previous spectroscopic studies had failed to detect these molecules because they absorb only weakly in the infrared. The new observations were made with a highly sensitive spectrometer that can detect even very faint infrared absorption.

An international research team, which includes Owen, reported the work last week at the annual meeting of the American Astronomical Society's Division for Planetary Sciences in Munich, Germany.

The findings, says Owen, may shed new light on a long-standing puzzle: why researchers have detected so little nitrogen in interstellar clouds of gas and dust – the raw material for stars – even though stars themselves contain a high abundance of the element. He notes that the heat from stars would split molecular nitrogen, which consists of two atoms bound together, into single atoms, which more readily absorb light and are easier to detect.

Astronomers had theorized that much of the missing nitrogen in the chilly interstellar medium may lie hidden in its harder-to-observe, molecular form. But they lacked convincing proof. Because Pluto preserves primordial abundances of materials on its icy surface, detecting a significant amount of molecular nitrogen on the planet offers further support for the notion that the cold interstellar medium also contains lots of molecular nitrogen, Owen notes. *– R. Cowen*

Threat perceived from emerging microbes

Developed countries such as the United States have become too complacent about medical science's ability to snuff out whatever novel infectious diseases may flare up, warns a report released last week by the Institute of Medicine, an arm of the U.S. National Academy of Sciences. As a consequence, the report concludes, modern society has left itself vulnerable to the emergence of new microbial infections, some of which have the potential to sweep the globe with the severity of AIDS.

Lyme disease, drug-resistant tuberculosis, and the mysterious streptococcal bacterium that killed "Muppets" creator Jim Henson are all 20th-century illustrations that existing antibiotics and vaccines can't completely insulate humans from infectious disease, says Robert E. Shope, who co-chaired the committee that drafted the new report.

"The medical community and society at large have tended to view acute infectious diseases as a problem of the past, but that assumption is wrong," says Shope, an epidemiologist at Yale University School of Medicine. "The danger posed by infectious diseases has not gone away – it's worsening."

The report, drafted by a 19-member panel of physicians and scientists, asserts that the United States lacks the ability to mobilize quickly against emerging infectious diseases. For example, it concludes that all of the yellow fever vaccine stocks in North America would be exhausted within several days if the disease were to break out in New Orleans – a city that was hard hit by yellow fever early in this century and that still harbors the mosquitoes capable of spreading the disease. In such an outbreak, 100,000 people would become ill with yellow fever and 10,000 would die within three months, according to the report, titled "Emerging Infections: Microbial Threats to Health in the United States."

To prevent such an occurrence, the committee calls for creating stockpiles of drugs and vaccines or establishing centers, modeled on the Department of Energy's national laboratories, that could increase production of such pharmaceuticals at a moment's notice. The committee also recommends improving current disease surveillance programs and training private physicians and small hospitals to consistently report cases of suspected new microbial diseases to the Centers for Disease Control. In addition, the committee proposes developing new pesticides to combat the organisms that spread infectious diseases.

Microbiologist Joshua Lederberg of the Rockefeller University in New York City, the other co-chairman of the committee, estimates that implementing all of the panel's recommendations in the United States would require less than half a billion dollars. "This is not a megaprogram," Lederberg comments. He adds that while the panel did not draft a budget detailing the costs of their suggested changes, "even tens of millions would make a very big difference."

"Although we do not know where the next microbe or virus will appear . . . we know that new outbreaks are certain," says Shope. "Unless we become more vigilant, some of these outbreaks could become deadly epidemics." *– C. Ezzell*

Pinatubo deepens the Antarctic ozone hole

When it came time for the annual ozone pool this year, researchers at NASA's Goddard Space Flight Center all missed the mark. Everyone guessed total ozone concentrations would come close to, if not surpass, the record low value because the atmosphere was filled with volcanic acid from last year's eruption of Mt. Pinatubo – a factor believed to help human-made chemicals in their attack on the ozone layer. Yet satellite measurements from early October showed that ozone levels did not fall as low as expected, so the highest prediction won by default.

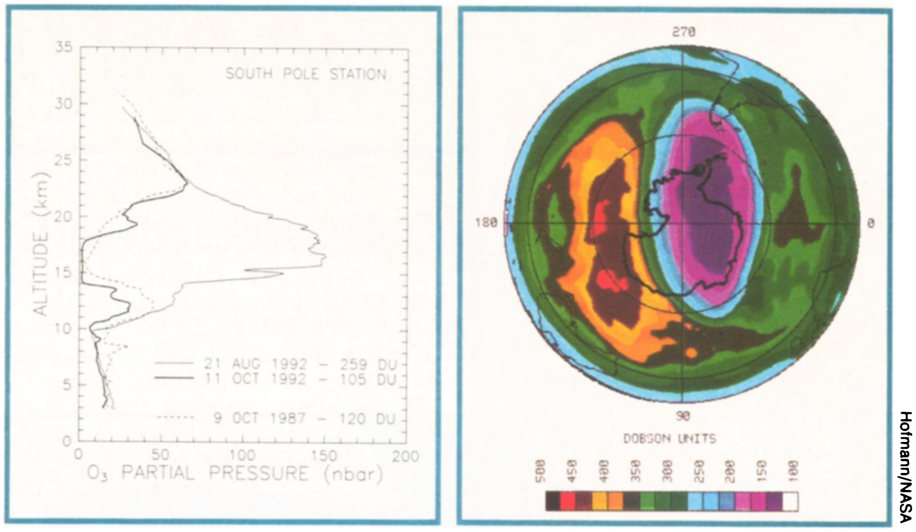
Measurements by balloon-borne instruments, however, now threaten to reopen that contest. In contrast to the satellite data – which indicate that this year's lowest ozone concentration was roughly 126 Dobson units – balloon measurements made on Oct. 11 show that ozone levels above the South Pole reached an all-time low of 105 Dobson units. The balloon data also suggest that sulfuric acid from Pinatubo did indeed worsen the ozone loss by allowing chlorine chemicals to attack ozone farther down in the stratosphere than normal, says David J. Hofmann of the National Oceanic and Atmospheric Administration in Boulder, Colo.

At this point, the satellite and balloon teams cannot tell which set of measurements lies closer to the truth. In either case, though, Earth's protective ozone shield suffered a particularly severe attack this year. In late September, the satellite-borne detector showed that the ozone hole had reached record proportions in terms of aerial extent (SN: 10/10/92, p.229). Atmospheric scientists are currently debating why its breadth grew so large this year.

At the time, the depth of the hole – the ozone levels measured where the shield is weakest – also seemed on the way to a record. But in the last week of September and early October, a huge, ozone-rich patch of air over the South Pacific pushed its way over the edge of the Antarctic continent. The Pacific air distorted the circling vortex of winds that normally encloses the Antarctic stratosphere and helps chlorine destroy ozone there. Weakened by the disturbance, the vortex took on an oblong shape and shifted toward the Atlantic, says Arlin J. Krueger of NASA Goddard in Greenbelt, Md. This event slowed the ozone destruction.

While satellite instruments give a broad aerial view of the hole, balloon measurements can show how much ozone resides at specific levels of the atmosphere. The balloon launches revealed unusually severe ozone loss this year in the lower part of the stratosphere, between 10 and 18 kilometers in altitude, Hofmann says.

Chemical reactions destroyed all ozone in a 4-km-thick layer between the altitudes of 14 and 18 km. This contrasts with the pattern seen in previous years, when total ozone loss occurred in a region only 1 to 2 km thick. Moreover, the chemical attack in years past spared ozone between 10 and 13 km high. This year, that layer lost about a third of its ozone, says Hofmann.



In graph of balloon data, thin line represents conditions prior to 1992 hole. Thick line shows loss this year. Dotted line indicates loss in 1987. Satellite image shows ozone-rich air (in red and orange) displacing ozone hole (in blue and purple).

Normally this low region is too warm for the formation of frozen cloud particles that hasten the ozone destruction process. But this year, ground-based and balloon-borne instruments detected a significant number of small particles in the lower stratosphere. Hofmann suggests the particles were droplets of volcanic sulfuric acid that helped chlorine chemicals extend their destructive power even lower in the polar stratosphere than normally possible.

In the Sept. 24 NATURE, Hofmann and colleagues reported seeing a similar – but less severe – phenomenon last year, when the lower stratosphere contained sulfuric acid from the eruption of Mt. Hudson in Chile. These particles should have dropped out of the stratosphere by now, but the droplets from Pinatubo's much higher cloud should still remain up there, says Hofmann.

While the Antarctic ozone hole comes during its spring, balloon launches in May and June suggest that this region also suffered some ozone destruction during the fall season as a result of the volcanic particles, says Hofmann.

– R. Monastersky

Electron chemistry, detector physics

Electron behavior lies at the heart of the research that merited this year's Nobel Prizes in Physics and in Chemistry.

French physicist Georges Charpak of the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, won the physics prize for the invention and development of electronic particle detectors capable of tracking the ephemeral subatomic products of high-energy collisions between particles in accelerators.

Canadian-born physical chemist Rudolph A. Marcus of the California Institute of Technology in Pasadena won the chemistry prize for theoretical work elucidating the intricacy of chemical processes involving the transfer of electrons between molecules in solution.

In the late 1960s, Charpak invented the "multiwire proportional chamber" to cope with the demands of rapidly characterizing the large numbers of extremely short-lived, exotic particles created during high-energy interactions. His device consisted of a flat, closely spaced array of thin, parallel, positively charged wires placed between two negatively charged plates in a gas-filled chamber.

Any charged particle entering the chamber would tear electrons away from the gas atoms or molecules inside. The freed electrons would then stream toward the positively charged wires, producing electrical signals that could be amplified and sent directly to a computer for recording and analysis.

Such an arrangement, which ended reliance on photographed particle tracks in bubble chambers and inaugurated the age of electronic particle detection, allowed physicists to pinpoint individual particle trajectories with improved precision while handling hundreds of thousands of such events per second. Thus, researchers could sift through billions of interactions to focus on rare but particularly interesting examples of exotic particles.

Descendants of this type of detector played key roles in the discoveries of several new particles, including the W and Z particles. The Superconducting Super Collider, under construction near Waxahachie, Texas, will have similar detectors.

In the 1950s and '60s, Marcus, while at the Polytechnic Institute of Brooklyn and later at the University of Illinois at Urbana-Champaign, developed a theory describing how electrons can jump from one molecule to another without breaking chemical bonds. He found simple mathematical expressions for the way changes in the molecular structure of reacting molecules and their neighbors affect the energy of a molecular system. He could then calculate the rates of electron-transfer reactions and explain the surprisingly large differences in the rates at which various reactions occur in terms of these molecular rearrangements.

Initially controversial, Marcus' theory was vindicated by experimental work in the 1980s. His theory illuminates a variety of important chemical processes, from photosynthesis and chemiluminescence to corrosion and the behavior of electrically conducting polymers. *– I. Peterson*