# Carbon dioxide can help dissolve proteins

Take a deep breath, then sigh. That exhaled carbon dioxide ($CO_2$), the ubiquitous gas enjoyed by plants and blamed for the greenhouse effect, has just proved helpful in laboratory biochemistry. For the first time, researchers have demonstrated that heated, pressurized carbon dioxide can dissolve proteins.

Known for adding effervescence to mineral water and soft drinks, the gas also finds industrial use in processing beer, removing nicotine from tobacco, and pumping oil from wells. Under pressure, it serves as a powerful, environmentally friendly solvent, replacing many of the hazardous, toxic organic solvents used widely by industry.

Now, there's likely to be a demand for carbon dioxide in biotechnology laboratories as well, says Eric J. Beckman, a chemical engineer at the University of Pittsburgh.

"Not only is $CO_2$ more environmentally acceptable and naturally abundant than organic solvents," says Keith P. Johnston, a chemical engineer at the University of Texas at Austin, "but it is also nonflammable, essentially nontoxic, and the least expensive solvent after water."

At normal atmospheric pressure, carbon dioxide freezes directly from a gas into a solid—dry ice. Only above 31°C and 73.8 atmospheres does it exist as a fluid. At the transition point, it becomes a supercritical fluid with industrial uses that include decaffeinating coffee, spray paint propulsion, fiber manufacture, and soil cleanup.

Decaffeinating coffee beans with carbon dioxide shows why the new method has great potential, says Alan J. Russell, a biochemist at Pittsburgh. "If a technique can selectively pull molecules of caffeine out of a mixture as complex as a coffee bean, then perhaps the same technique could be used to pull a specific protein out of a group of cells.

"There aren't many techniques capable of doing that," he adds. "This one could prove to have great utility."

Johnston's team describes in the Feb. 2 SCIENCE a method for employing carbon dioxide to dissolve proteins, making it potentially useful in biotechnology. Mixing supercritical carbon dioxide with pressurized water, the researchers made "water-in-$CO_2$ microemulsions," which they used to dissolve a protein called bovine serum albumin.

This work may help to "pave the way for use of $CO_2$ in extraction and purification of biomolecules, an exciting application that had previously been thought untenable," says Beckman in an accompanying article in SCIENCE.

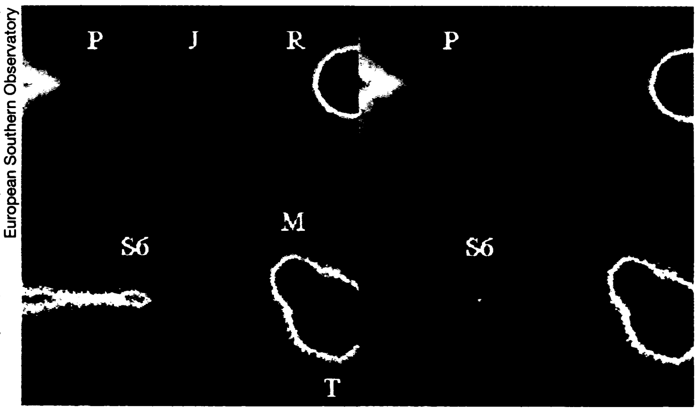
The way microemulsions dissolve proteins resembles the way soapy water breaks up dirt during laundering. "When you dissolve soap in water, the mixture forms tiny [droplets], called micelles, which will solubilize oil and grease," Beckman explains. "In the water-in-$CO_2$ microemulsions, the micelles function as tiny chambers for dissolving molecules."

Industrial advantages of carbon dioxide over standard solvents come from its ease of use, says Beckman. No government agency regulates use of the gas, it can easily be removed from and returned to the environment, and at 4 cents per pound, it is "probably the least expensive organic solvent one can obtain commercially."

Although carbon dioxide remains a weaker solvent than its volatile cousins, it could replace hazardous, toxic solvents in processes where residues could prove harmful to people—for instance, in purifying food or preparing pharmaceuticals. *—R. Lipkin*

# New Saturn moons or only transient debris?

Rather than discovering several new satellites of Saturn recently, as some astronomers originally reported, the Hubble Space Telescope may only have spied clouds of ice and dust orbiting the ringed planet. Some of that debris, however, may represent remnants of tiny, shattered moons.




European Southern Observatory

*False-color images show inner moons of Saturn (Pandora, Janus, Rhea, Mimas, and Tethys), as seen by the European Southern Observatory's 3.6-meter telescope in La Silla, Chile. Upper panels show western edge of Saturn's ring plane. Bottom panels reveal newly discovered object S6, thought to be a transient clump rather than a new moon.*

On May 22 and again on Aug. 10, Earth crossed the plane in which Saturn's rings orbit the planet. On Nov. 19, the sun followed suit. During such events, which occur only once every 15 years, the rings lose their brilliance, allowing Saturn's faint moons to become visible. Many of the planet's known moons were discovered under these conditions.

Last summer, Amanda S. Bosh of Lowell Observatory in Flagstaff, Ariz., and Andrew S. Rivkin of the University of Arizona in Tucson announced that during the May 22 ring-plane crossing, Hubble detected two objects never seen before. Both appeared to be moons of Saturn (SN: 8/5/95, p. 87). But after analyzing the data further, Bosh has now determined that only one of the bodies is a new moon. The other, dubbed S3, has an orbit so similar to one of Saturn's outer rings, the F ring, that it in fact represents a small clump of material from the ring.

From Hubble images taken during the Aug. 10 crossing, Philip D. Nicholson of Cornell University and his colleagues detected two never-before-seen bodies as well as S3. The team has concluded that none is a moon. Nicholson says the objects must have been created during the last 14 years, because they are too big and too bright for the Voyager craft to have overlooked them during Saturn flybys in the early 1980s. In addition, the brightest of the three bodies is elongated, unlike a satellite.

All three objects seem to have disappeared by Nov. 21, when Hubble again viewed Saturn, Nicholson notes. Bruno Sicardy, an astronomer at the Paris Observatory in Meudon, France, suggests that the objects, thought to lie near the F ring, disappeared precisely because of their location.

In the neighborhood of the F ring, Saturn's tidal pull—the difference in gravitational tug from opposite sides of the planet—could break off a piece of a small moon. This loose package of material would briefly form a cloud of debris bright enough to be seen by a telescope.

Sicardy says the August and November observations reveal that material near the F ring breaks loose and is destroyed in a matter of weeks. The Voyager craft found evidence of such activity, but the new images mark the first time that observations from Earth's vicinity have documented it.

"This is even more interesting than finding new satellites," Sicardy declares, noting that similar processes probably occurred when many of the planets first formed moons and rings.

Earth will again cross Saturn's ring plane on Feb. 11, but the sun will lie too close to Saturn for Hubble to view the event. *—R. Cowen*



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