

ier solar wind reached the heliopause. At this boundary, the solar wind must halt: Pressure from the interstellar wind equals the pressure from the solar wind. This collision created intense bursts of radio waves, some of which headed back into the solar system and were detected by the Voyagers, he speculates.

Gurnett says measurements from different orientations of the Voyagers indicate the bursts come from where the solar wind collides head-on with the interstellar wind. He adds that the emissions have gradually shifted to higher frequencies. This suggests a well-defined heliopause width, with lower-frequency radio bursts created earlier at the boundary's near, lower-density edge, and higher-frequency signals created later, when some of the solar wind penetrates deeper into the heliopause's denser parts.

Researchers a decade ago had proposed that the heliopause would lie closer to the sun, about 70 AU distant. Based on the new radio data, Gurnett places it some 100 to 160 AU from the sun. Ralph L. McNutt Jr., of Johns Hopkins University Applied Physics Laboratory in Laurel, Md., estimates the boundary may lie between 90 and 120 AU away. These new estimates are consistent with recent Hubble Space Telescope data that suggest a distance of 100 AU (SN: 5/22/93, p.326).

— R. Cowen

## Method probes chemistry of stroke, aging

A technique used to measure fats and proteins in food products may now help scientists detect chemical changes in the brain that occur with stroke and aging, a group of researchers reports.

Robert A. Lodder and his co-workers at the University of Kentucky Medical Center in Lexington have found that, in gerbils, near-infrared light can penetrate the skull to reveal the degree of tissue oxidation — the chemical damage to fats and proteins — in the brain.

"We actually get the scans through the skull, the hair, and the brain and get chemical information back," says Lodder. But some scientists express skepticism about applying the work to humans.

The technique, called near-infrared spectrophotometry, gives researchers a non-invasive tool for probing the chemistry of living systems. While magnetic resonance imaging (MRI) and CAT scans provide excellent views of anatomical structure, they reveal little about molecular structures. Hospitals use near-IR spectrophotometric devices to monitor the oxygen-carrying state of hemoglobin in the blood of newborns suffering respiratory distress, and health clubs use the technique to estimate patrons' body fat. The Kentucky group, however, is the first

to adapt the method for stroke and aging research, Lodder says.

The team shines a beam of near-IR light onto the head of an anesthetized gerbil. A spectrophotometer measures the amount of light, in wavelengths from 1,100 to 2,500 nanometers, transmitted through the brain. A supercomputer then analyzes the data and cranks out a graph showing the amounts and types of fats and proteins. After a stroke or with increasing age, the lipid signals shift to longer wavelengths, the group reports in the May 15 issue of *ANALYTICAL CHEMISTRY*. This observation suggests that unsaturated fatty acids convert — by oxidation — to saturated ones, or else switch the configuration of the molecule from the cis to the trans form.

Using the near-IR analytical method, Lodder's team found that these damaging changes, when spurred by a stroke, take place well after the initial clot prevents oxygen from reaching the tissue. They studied the near-IR scans of three gerbils given deliberate 10-minute strokes and found that oxidative damage began at least four hours after circulation was restored. By then, reactive chemicals called free radicals, which build up in the oxygen-starved area, would have begun attacking nearby tissues, the researchers believe.

Normal mammalian metabolism generates smaller quantities of free radicals, resulting in similar brain tissue damage that accumulates with age, Lodder says. His group could discern no difference in the near-IR scans of a young adult gerbil subjected to 10 minutes of stroke and an aged one that had a 5-minute stroke. "It looks like stroke is just an accelerated aging process, at least according to this near-IR test," he says.

Lodder's group is using near-IR to gauge the effectiveness of free-radical-quenching drugs that could potentially treat stroke and diseases of aging. The new technique reduces the number of animals needed for such studies, he notes. Because the method also detects water, the team hopes to adapt it to evaluate edema in humans, including by concussion.

Biophysicist Britton Chance of the University of Pennsylvania in Philadelphia says, "This paper calls attention to the great potential of red-light spectroscopy of tissues. But evaluation of edema is more important than the changes of brain fats, and penetration deeper than 4 millimeters will be necessary for application to the human brain."

Karl Norris of Beltsville, Md., who developed the fat meter, voices deeper skepticism. "My opinion is that they're only seeing signals from the surface of the brain," he comments. "I'm concerned that we are extrapolating too far with this technology."

— K.F. Schmidt

## Chlorination products linked to cancer

A report published last summer offered the first strong link between chlorinated drinking water and an increased risk of human bladder and rectal cancers. But this epidemiologic study could not tease out the agent responsible — chlorine, by-products of the disinfectant's reaction with water contaminants, or both (SN: 7/11/92, p.23). A new animal study now fingers the by-products as the most likely culprits.

For two years, scientists at the National Institute of Environmental Health Sciences in Research Triangle Park, N.C., fed hundreds of mice and rats water containing a drinking-water disinfectant — either chlorine (Cl<sub>2</sub>) or chloramine (NH<sub>2</sub>Cl). In a concurrent study, they laced the diets of rodents with chloroform, bromodichloromethane, chlorodibromomethane, or bromoform — trihalomethanes (THMs) that typically form in chlorinated water. Each experiment included 50 mice and 50 rats of each sex.

In animals administered chlorine or chloramine, "the only evidence of carcinogenicity... was an equivocal response for leukemia in female rats," June K. Dunnick and Ronald L. Melnick report in the May 19 *JOURNAL OF THE NATIONAL CANCER INSTITUTE*. However, compared to rodents eating an ordinary diet, those dining on food containing a THM showed

not only liver and kidney toxicity, but also unusually high rates of cancer.

For instance, tumors of the kidney and colorectum normally occur in fewer than 1 percent of rats, the investigators note. The new research shows that one-quarter to one-third of rats treated with chloroform, bromoform, or bromodichloromethane developed kidney cancers. Between 25 and 90 percent of the rats fed one of those three THMs also developed both precancerous and malignant colorectal tumors.

"This study provides some of the clearest evidence yet of [chlorination's] carcinogenicity, particularly its colorectal carcinogenicity," says Robert D. Morris of the Medical College of Wisconsin in Milwaukee. However, THMs may not be the only carcinogens formed, he says, noting that only about half of chlorination's by-products have so far been identified.

The study also provides some of the first information on the relative potency of individual THMs, notes Stephen W. Clark of EPA's Office of Drinking Water Standards in Washington, D.C. Indeed, he says, these data will probably influence the new rules for THMs in drinking water now being negotiated by EPA and industry and environmental leaders.

— J. Raloff