Radio twinkling in Venusian ionosphere

Stars appear to twinkle because temperature variations create turbulence in Earth's atmosphere that changes its refractive index. Another kind of twinkling takes place in the ionosphere, the layer of charged particles at higher altitudes, where similar turbulence and other factors cause the number of electrons to fluctuate.

The result can be radio interference, and scientists now report what they call the first clear evidence that similar scintillations take place in the ionosphere of Venus.

The effect has been observed not only at Earth but also at Jupiter, Saturn and Uranus, where it has affected the radio signals of interplanetary spacecraft. All these planets have substantial magnetic fields, where interactions between spinning electrons and the magnetic field lines cause the "twinkles" in radio waves passing through their ionospheres. But it was unclear what the situation would be at Venus, whose magnetic field is extremely weak if it exists at all.

William L. Sjogren of Jet Propulsion Laboratory in Pasadena, Calif., was mapping the Venusian gravitational field by measuring the Doppler shift in radio signals from the Pioneer Venus Orbiter spacecraft, which has been there since 1978. Last year, however, in reanalyzing the data, he grew frustrated at what seemed to be "noise" that showed up sometimes in the signals. At first he suspected the solar wind (because the noise was detected during the solar-cycle maximum, when the solar wind is often strong) or electronic static caused by the spacecraft itself or its instruments.

But Richard Woo of Jet Propulsion Laboratory, together with Sjogren and other colleagues, now reports in the Feb. 1 Journal of Geophysical Research that Venus makes ionospheric twinkles on its own. They have not shown up often, Woo says; perhaps a month of twinkles occurred during the spacecraft's decade on the job. But that could be because Pioneer Venus spent most of its time orbiting too high for its Earthbound radio beam to go through the ionosphere.

The solar wind does play a part. Some other planets hold the solar wind at bay by magnetic fields, but on Venus it sometimes gets close enough to cause variations in the ionosphere's electron density, which can give a case of the twinkles to a radio beam passing through. That only happens, however, when the pressure of the incoming solar wind exceeds that of the ionospheric plasma facing it.

At Venus, the twinklings occur only in the subsolar region — the part of the ionosphere directly facing the sun — whereas in Earth's ionosphere they show up in both polar and equatorial regions, with additional peaks occurring during nighttime.

Another planet with little or no magnetic field but at least some atmosphere and ionosphere is Mars. (Scientists still differ on whether the planet has an intrinsic magnetic field, and the Soviet Phobos 2 spacecraft probably will not get close enough to measure a weak one.) Is Mars likely to show the twinkles, too?

The likely answer is yes, suggests Janet G. Luhmann of the University of California, Los Angeles. In fact, she says, the day side of the Martian ionosphere may show such scintillations all the time. Mars is farther from the sun than Venus is, and it has a much thinner atmosphere, so its ionosphere is less substantial, too, and the solar wind easily gets in to stir it up.

The Venus study shows spacecraft can detect the twinkles without entering the ionosphere, as Pioneer Venus did, if they can send a radio beam through the ionosphere to the Earth. This suggests that Mars twinkles should be detectable with both the Soviet Phobos 2 mission and the upcoming U.S. Mars Observer, to be launched in 1992. — *J. Eberhart*

Ozone violators increase

One repercussion of last summer's parching heat appears to be a dramatic increase in the number of cities or regions exceeding the U.S. smog-ozone standard. Though final 1988 air-monitoring data are not due at the Environmental Protection Agency until July, EPA announced last week that preliminary information indicates it will have to add 28 new areas to its list of regions surpassing the national ambient-air-quality standard for ozone — an increase of 41 percent in ozone violators. The potential new violators include areas as populous as Denver (1.8 million) and as rural as Greenbrier County, W. Va. (39,000).

Ozone, the primary irritant in smog, forms in the lower atmosphere when sunlight reacts with hydrocarbons and nitrogen oxides. Hot, clear days accelerate ozone production. Environmentalists anticipate the new data may spur policymakers revising the Clean Air Act to write in tougher sanctions for violators — especially for those lacking strict ozone-control plans. □

Clues to a new class of liver carcinogens

Peroxisomes are a curiosity. These round, dense constituents of plant and animal cells harbor enzymes to make and break hydrogen peroxide (H_2O_2). While it's unclear what beneficial role, if any, peroxisomes play in mammalian cells, new research suggests they can become the means by which one class of chemicals triggers the development of apparently novel liver cancers.

A number of potentially important chemicals — including several powerful cholesterol-lowering drugs, herbicides and plasticizers — are liver carcinogens that uniformly elude detection by short-term carcinogen-screening assays, such as the Ames test. The reason, explains toxicologist Janardan Reddy at Northwestern University Medical School in Chicago, is that the short-term screening tests look for chemicals that cause genetic mutations in bacteria. But the liver carcinogens he studies don't interact directly with DNA. Instead, they trigger the liver to produce peroxisomes — 15 to 20 times the normal number.

These peroxisome-proliferating chemicals (PPCs) also activate a trio of genes inside liver-cell nuclei. Within minutes to hours of PPC exposure, the genetic trio stimulates a cell's peroxisome production of H_2O_2 — to levels 30 or 40 times normal. Meanwhile, a peroxisome's H_2O_2-degrading enzymes will not even double.

Elevated peroxisome-H_2O_2 concentrations, caused by this mismatch between its production and breakdown rates, eventually result in large quantities of the potentially toxic chemical diffusing into liver cells. There it reacts with metals, such as iron and copper, forming toxic "free radicals" — highly reactive molecular fragments, such as hydroxyl (OH). "We feel that the hydroxyl radical produced by H_2O_2 over time causes the DNA damage or whatever is needed to induce a cancer," Reddy says.

In the January Toxicology and Applied Pharmacology, Reddy and his co-workers report data indicating that the liver is the sole target of PPC toxicity and suggesting that PPC-induced cancers form quite differently from other liver cancers. Two proteins that serve as markers of classical liver tumors — gamma-glutamyltranspeptidase and glutathione S-transferase-P — are conspicuously absent in PPC-induced tumors. Reddy says this suggests the PPC free-radical process may trigger a new cancer-causing gene.

It also suggests, he says, that chemicals appearing benign in short-term carcinogen screening tests should be subjected to two-week peroxisome-proliferation assays in animals before further commercial development goes ahead. Although not required to do so, a few U.S. companies have begun subjecting suspect chemicals to such tests.

Preliminary data indicate rats and mice are much more sensitive to PPCs than are humans. If tissue-culture studies prove useful in identifying exposures below which no peroxisome proliferation occurs — "we may be able to determine the risk of these useful chemicals" and design nontoxic exposures to them, Reddy says. — *J. Raloff*