Saturn's Belt of Lightning: 40,000 Miles of Zap

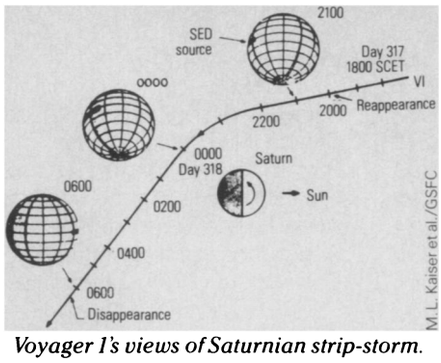
The list of the wonders of Saturn continues to grow, from its thousands of formerly unimagined ringlets to its 1,100-mile-per-hour equatorial winds. Now a reanalysis of data from the two Voyager spacecraft, which went there in 1980 and 1981, has suggested yet another dramatic phenomenon: a truly gargantuan lightning storm, 40,000 miles long, wrapping a sixth of the way around the planet (equivalent to nearly twice around the earth) and lasting at least the 10 months between the flybys.

What the Voyagers actually recorded was a peculiar kind of static, which indeed seemed to resemble the radio emissions triggered by lightning. It came in short bursts every few seconds, covering a wide range of frequencies, and the bursts occurred in episodes whose regular timing suggested that whatever their source might be, it was circling Saturn's axis about every 10 hours 10 minutes. Some Voyager scientists pointed out, however, that the emissions extended down to frequencies as low as 20 kHz, while the density of electrons in the planet's ionosphere (as measured by other instruments on the Voyagers and the earlier Pioneer 11) should have kept in any atmospheric signals lower in frequency than about 1 MHz, so that they would never reach the spacecraft. Thus, it was reported, the source of the bursts "clearly is not in the electrical discharges that might be expected to occur in the cumulonimbus clouds over Saturn."

Furthermore, it was noted, the 10^h10^m period of the burst episodes, though shorter than the planet's $10^h39.4^m$ day, corresponded to the orbital period of particles about 30,000 miles out in the rings. Perhaps, then, the source of the bursts (dubbed Saturn electrostatic discharges, or SEDs) was there, possibly a result of charges built up by collisions between the ring particles.

A year ago, however, at a meeting devoted solely to Saturn studies, Joseph A. Burns of Cornell University pointed out that the rings cast a large shadow on the planet's near-equatorial ionosphere, possibly reducing its electron density enough for the SEDs—low frequencies and all—to escape outward from the atmosphere. Now Michael L. Kaiser, J.E.P. Connerney and Michael D. Desch of the National Aeronautics and Space Administration's Goddard Space Flight Center suggest that the SEDs' "escape hatch" may in fact be far larger: the entire night side of Saturn.

In their analysis, reported in the May 5 NATURE, the researchers compared the duration of the burst episodes, the amount of Saturn's nightside visible to the spacecraft at any given time, and the frequency



Voyager 1's views of Saturnian strip-storm.

range of each burst. The clue that the atmosphere rather than the rings might truly be the source, says Kaiser, came "like a blinding flash" when he realized from a graph of the raw data that the bursts recorded in the few hours *before* each Voyager's closest approach to the planet actually contained no frequencies lower than about 5 MHz. Only those measured during and after the flybys showed the wideband emissions—and those were the ones taken when the spacecraft were largely facing Saturn's nightside. The pre-approach bursts were recorded over the dayside, where the density of the ionosphere is greatest.

The other part of the story lies in the fact that the periods of burst activity, though they are centered 10^h10^m apart, were also separated by about three hours of near-silence. Those, the Goddard team maintains, would have been the times when the SED source was hidden from each spacecraft's view. For a point-source 30,000 miles out in the rings, the researchers calculate, such "occultations" would have lasted only about two hours or less, since the ring-source would have been visible around a greater portion of Saturn's circumference. On the other hand, a single, localized lightning storm in the atmosphere would have promptly disappeared behind Saturn's limb, or edge, producing an occultation of about five hours. The only possible answer, the Goddard team reasons, would be if the source were a long, strip-like region in the atmosphere, extending, by the group's calculations, over 60° of Saturnian longitude—a span of nearly 40,000 miles. (A strip-source in the rings would shorten the occultations to *less* than two hours.) The proposed strip of atmosphere "readily" explains the low-frequency cutoff of the early measurements by the fact that it was then on the dayside of the planet.

The 10^h10^m period of the proposed strip suggests that it may not be right along the equator, but instead at about 4° north latitude, where Voyager's photos show cloud features to be moving with the same period. There may also be a corresponding southern-hemisphere region, but cloud features there could not be photographed because of the ring system's shadow, Kaiser says. The Voyagers did not detect similar lightning "signatures" at earth and Jupiter, he notes, simply because there are too many to isolate individual bursts — about 100 per second at earth and up to 80,000 at Jupiter, while Saturn shows only about one in five seconds. Question: Why? —*J. Eberhart*

Canine clues to narcolepsy

Human narcoleptics lead a dog's life: crippled by severe and incurable daytime sleepiness, they are often barred from the most normal human activities — driving an automobile, holding a job. Even very slight emotional arousal (a funny joke, for example) can trigger attacks of physical paralysis and irresistible napping; and many narcoleptics suffer in addition from terrifying hallucinations, a condition that has led to frequent misdiagnosis of schizophrenia.

Although physicians have known about narcolepsy for more than a century, scientists made little progress in understanding the disorder until a decade ago, when it was discovered that dogs also suffer from narcolepsy. With this natural animal model, scientists at Stanford University School of Medicine have been breeding narcoleptic dogs to study the genetics, electrophysiology and biochemistry associated with the disorder; and last week they reported the first evidence of a specific brain abnormality that appears to be consistently linked with canine narcolepsy.

Writing in the May 6 SCIENCE, Ivan N. Mefford (now at Boston College) and a team of Stanford neuroscientists (headed by Theodore L. Baker) report that they have found abnormally high concentrations of the neurotransmitter dopamine in several brain regions of narcoleptic dogs. The dopamine is concentrated within nerve endings rather than in the synapses, suggesting a problem with the normal release of the chemical messenger. Dopamine is suspected of playing a role in alertness, Baker told SCIENCE NEWS, and amphetamines, which are used to treat sleepiness, act in the brain by releasing dopamine.

In addition to the abnormal dopamine concentrations, Baker and his colleagues have also found a proliferation of brain stem receptors for another neurotransmitter, acetylcholine, suggesting that nar-