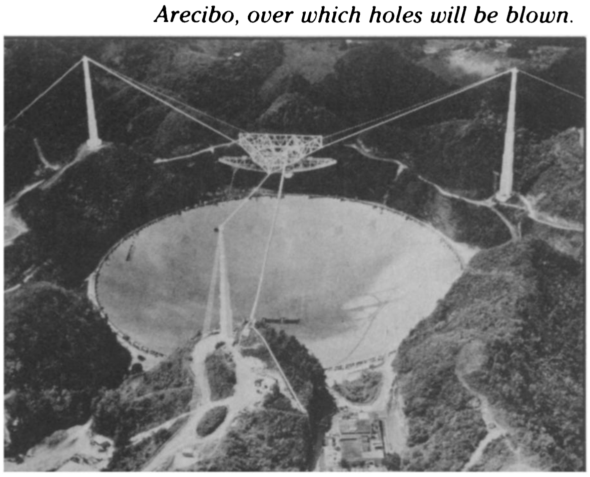
Punching Holes in the Sky

On May 14, 1973, the day the Skylab workshop was launched from Florida by the last of the huge Saturn V rockets, researchers at the Air Force Geophysics Laboratory in Massachusetts were working on what seemed to be a completely unrelated task. They were monitoring transmissions from the ATS-III satellite as an indicator of the number of ions and free electrons in the ionosphere, through which the signals were passing on their way to the ground. Even when, shortly after the launching, the number abruptly dropped by about 60 percent, no one was immediately aware of any obvious link between the two events.

It took a year, says Michael Mendillo of Boston University, to figure out the "Skylab effect." The combustion products of the hydrogen and oxygen propellants in the rocket's second stage, spewing out within the ionosphere, had reacted with the ionosphere's positively charged 0^{+} ions to form the positive molecular ions H_20^{+} and OH^{+}. These in turn reacted with the local free electrons (which are negatively charged), thereby becoming neutral and effectively taking the electrons out of circulation. The result, at least in terms of free electrons: an artificially produced "hole" in the ionosphere, lasting for more than an hour and extending for hundreds of kilometers. As viewed from Massachusetts, the ATS-III signal path simply happened to pass through the hole. In previous Saturn V launchings, the second-stage engines had been fired below the level of the ionosphere, so the effect had not appeared.

It was a newly discovered process, says Mendillo, involving fundamental processes of the ionosphere. But besides suggesting a new area of basic research, the effect seemed to have some real applications. Mendillo and Michael D. Papagiannis, also of BU, proposed that sounding rockets with haloes of water could be used to create such holes deliberately, in order to temporarily increase the ionosphere's transparency to the wavelengths used in low-frequency radioastronomy.

Arecibo, over which holes will be blown.



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Study of the holes may also prove important in evaluating the possible environmental effects of the proposed solar power satellites (see p. 256), whose in-orbit construction could require launching great numbers of rockets that would release large quantities of water into the upper atmosphere or ionosphere. Morris Pongratz and Gordon Smith of the Los Alamos Scientific Laboratory in New Mexico suggest that data on the holes could even be relevant to long-range climate studies. It has been proposed that earth's passage through the spiral arms of the galaxy may be connected with the triggering of ice ages (SN: 7/12/75, p. 23), and some theorists feel that the enhanced molecular hydrogen in the spiral arms could lead to ionospheric depletions similar to the Skylab effect.

The first attempt at deliberately generating an ionospheric hole was less than a resounding success. A sounding rocket launched from Alaska in 1976 carried a can of water with an explosive device to release the water into the ionosphere. Unfortunately, says Mendillo, the rocket (for which the hole project was only a secondary objective) was launched at night, "when there is not much ionosphere anyway," and the explosive detonated at too low an altitude. There were also telemetry problems and other difficulties.

This week, however, researchers at the meeting of the American Geophysical Union in Miami Beach reported on two successful attempts, together known as Project Lagopedo (Spanish for ptarmigan, a feather-footed bird). A pair of sounding rockets were launched last Sept. 1 and 11 from the Hawaiian island of Kauai, carrying payloads of water and carbon dioxide. The vapors were deployed 262 and 283 kilometers (respectively) above the earth, well within the ionosphere, and each firing produced a "hole" about 50 kilometers across, heavily monitored both from the ground and from the rockets themselves.

A far more elaborate plan, Mendillo told the meeting, is now being planned for as early as 1981, to be conducted from the Spacelab research module aboard the space shuttle. As many as six holes will be created by the exhaust from the small engines of the shuttle's orbital maneuvering system, which will be fired at locations in orbit above five research facilities.

A firing over the huge Arecibo antenna in Puerto Rico (at about 18°N) will yield data on ionospheric depletion effects at low mid-latitudes. Higher-latitude effects will be studied with the aid of a hole over the 150-foot steerable dish at Millstone Hill, Mass., at about 41°N. Researchers at a facility at Roberval, Quebec, will study whether the holes can create a "preferential path" different from the earth's magnetic field lines for atmospheric "whistlers," while a dipole array at Jicamarca, Peru, will look for signs of ionospheric irregularities that show up as a "twinkle" in radio signals, similar to the optical twinkle of stars caused by thermal instabilities in the atmosphere. Finally, the possibilities of low-frequency radioastronomy, particularly below about 3 megahertz, will be studied using a "hole" over the large Llanherne/Reber antennas at Horbart, Tasmania.

The ambitious effort is scheduled for the second Spacelab flight, Mendillo says, which is tentatively expected to take place on the fourteenth or fifteenth mission of the space shuttle. □

Lipoproteins: A delicate balance

Women, Greenland Eskimos and marathon runners have at least two things in common — decreased risks of heart disease and high plasma levels of high density lipoproteins (HDL). Evidence is accumulating that the two may be related.

Cholesterol, a known felon in heart disease, circulates in the bloodstream bound to lipoproteins, conjugated compounds of lipids and proteins. These come in two basic types: high density (more protein than lipid) and low density (more lipid than protein). The latter type is divided into low density lipoproteins (LDL) and very low density lipoproteins (VLDL).

Certain species, such as the rat, that are resistant to atherosclerosis, primarily have HDL. Other species (pigs, most monkeys and, unfortunately, humans) circulate most of their cholesterol attached to low density lipoproteins and are prone to heart disease. However, even though humans for the most part have LDL, increased levels of high density lipoproteins may protect them against heart disease. Large epidemiological studies indicate that the more LDL present, the greater risk of atherosclerotic heart disease; increased amounts of HDL lower the risk.

Although it is still not clear whether HDL levels prevent the onset of atherosclerosis in humans or animals, researchers are intensely interested in why people with high density lipoproteins are resistant to disease and what alters the levels of the lipoproteins.

In atherosclerosis, cholesterol accumulates in the arterial walls. Apparently, low density lipoproteins with their bound cholesterol infiltrate the cells of the walls. The cholesterol keeps collecting and eventually coalesces into larger and larger

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