creased 10-fold over a decade, and the credibility of the governmental regulatory agencies has declined. He says the latest study of nuclear energy conducted by the American Physical Society (SN: 5/3/75, p. 286) shows that a serious accident involving thousands of deaths is expected to occur every couple of decades.

Not so, counters Lapp; Ford is mistaking probabilities for major and minor accidents, and the APS study actually predicts less than one death a year from nuclear accidents. As for the economic arguments, Lapp cites an Arthur D. Little study showing nuclear costs—including building the expensive plants—to be about half those of conventionally powered electric generation. In just the next five years, he concludes, the United States will save $13.7 billion because of the reactors already on line.

Several times Laird turns, after one of these acrimonious confrontations, to Moss, whom he met years ago as a White House Fellow. Yes, nuclear energy does have unresolved safety problems, Moss says, but so does coal. The current economic problems of reactors have mainly to do with the recession and a reassessment by the utilities of future growth, he continues. Since adequate energy conservation will not likely follow from altruism, new policies must "make sure that the user of energy pays the full cost of the energy he uses." Specifically, Moss recommends repealing the Price-Anderson Act that limits private liability in event of nuclear accidents, and also favors levying emission charges for users of coal and holding coal mining companies responsible for the $1 billion a year paid to victims of black lung disease.

The purpose of the program is to open the nuclear debate to a wide audience, freeing it from the specialists who have been the most vocal so far. "What is the comparison of risks?" asks Hosmer—but no consensus is reached. □

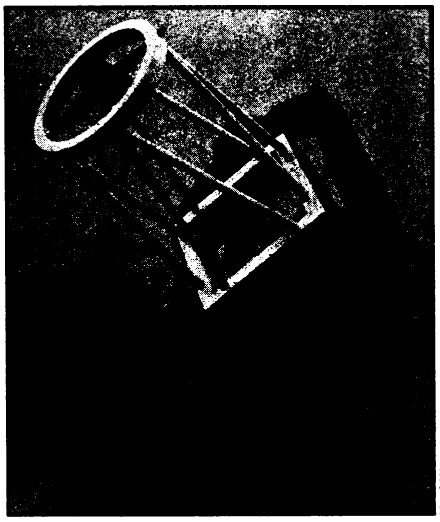
Wyoming site for 84-inch IR telescope

Infrared is a range of the electromagnetic spectrum little used by astronomers until very recently. Water vapor in the atmosphere absorbs infrared very heavily so most of the early work was done from balloons and rockets. But if you get to high enough elevation, the atmosphere gets thinner, and now with highly sensitive equipment it is becoming practical to do ground-based work. (An example is reported on p. 332.) That's where Wyoming comes in.

Wyoming: the bucking horse on the automobile tags, the Union Pacific chugging up Sherman Hill, the wide open spaces where the deer and the antelope—and very few people—play. And some very tall mountains.

"Laramie is a nice place to live," says Robert Gehrz of the University of Wyoming. "Right in the middle of the mountains." In those mountains an infrared telescope will be built that with a reflecting surface 84 inches in diameter will be the largest in the continental United States. The only larger one in the country is a 120-inch installation being built on Mauna Kea in Hawaii. The Hawaiian telescope is especially designed for planetary studies so the Wyoming instrument will be the largest in the country for stellar and galactic infrared observations.

The new telescope will be a national facility administered by the University of Wyoming. Funding, in the amount of $1.6 million, will be by the National Science Foundation and the State of Wyoming. It is rather unusual for a state to contribute to such a fund except through the budgets of universities, and in this case the state's contribution will be the larger share: $975,000 or almost three dollars per inhabitant. The state and other users will bear the operating costs.



U. of Wyoming

Planned infrared telescope in 1/24 scale.

Final choice of a site is expected soon. Two are in the running: Little Brooklyn Lake in the Snowy Range about 35 miles west of Laramie, elevation about 10,400 feet, and Jelm Mountain, 35 miles southwest of Laramie, elevation about 9,656 feet. In either case, as E. Gerald Meyer, vice president for research at the University points out, the high altitude, low temperatures and pollution-free sky produce the extremely dry atmospheric conditions that will enable observations in several infrared windows inaccessible from most existing observatory sites.

Construction is expected to begin this summer. Completion of the telescope, which has been designed by Astro-Mechanics Inc. of Austin, Texas, is planned for 1977. Gehrz, J. A. Hackwell and W. T. Grandy Jr., all of the University's Department of Physics and Astronomy, will supervise construction. □

A hole in ionosphere for astronomy

When the last of the Saturn 5 rockets carried the Skylab workshop into orbit in 1973, its passing left a huge, temporary "hole" in the ionosphere—a region about 2,000 kilometers across, swept nearly clean of its usual population of free electrons (SN: 2/1/75, p. 71). Now two Boston University researchers are proposing that such holes be made on purpose, with the promise of offering radio astronomers a new window to the sky.

It is those free electrons, replenished by photodissociation, that make the ionosphere "a nearly impenetrable barrier" for ground-based radio astronomy at low frequencies, point out Michael D. Papagiannis and Michael Mendillo. Yet the portion of the radio spectrum below about 30 megahertz carries important information about the heavens, from Jupiter's remarkable decametric bursts to the 3-MHz peak in the radio intensity of the whole galaxy.

At night, the number of free electrons drops sharply in much of the ionosphere—the so-called D, E and F1 layers—due to natural processes that cause the electrons to recombine with readily available ions. Higher up, however, in the F2 layer, such processes are far less active. And here is where what Papagiannis and Mendillo call the "Skylab effect" could be a valuable discovery.

The 1973 hole occurred when the hydrogen and water vapor in the exhaust of the Saturn rocket's second-stage engines combined with oxygen atoms in the F2 layer to form positively charged ions, which then combined with the negatively charged electrons. The effect could be easily duplicated, the astronomers point out in the May 1 NATURE, by deliberately injecting molecular hydrogen into the region from an inexpensive sounding rocket. It becomes merely a matter of injecting the hydrogen over the site of a radio telescope. "This artificial ionospheric window," they report, "should allow radio astronomical observations to be carried out from the ground between 1 and 6 MHz, and possibly at even lower frequencies."

At present, low-frequency radio astronomy is almost entirely limited to what can be done from satellites. This means, among other drawbacks, that angular resolution is almost inevitably poor because the wavelengths at such frequencies are usually longer than the satellite antennas. A single 1-MHz wave, for example, is 300 meters long. Ground-based observations allow not only larger single antennas, but also the possibility of interferometry through multiple antenna arrays.

In the mid-1950's, pioneer radio astronomers G. R. Ellis and G. Reber attempted low-frequency radio observations from the ground by trying to time their observations to coincide with the lowest possible ionospheric activity, combining diurnal, solar and seasonal cycles. It was a valiant effort, says Papagiannis, but the results were ambiguous. Ellis, at the University of Tasmania in Australia, is enthusiastic about the potential of the Skylab effect. Papagiannis quotes a letter from down under: "There is no doubt that the ability to create an ionospheric window over our telescopes [a 2,000-foot-square, 64-row, east-west array equipped for 2-20-MHz observations and a 1-km instrument with 24 simultaneous beams spaced 5 degrees apart now being rewired for 1-MHz listening] on even a few selected nights would speed up enormously the mapping of the southern sky between 2 and 10 MHz, and would be essential below 2 MHz."

A likelier candidate for a first test, however, would be the huge Arecibo dish in Puerto Rico, the Boston astronomers suggest, since it already has rocket-launching facilities. The idea, they maintain, would be to carry about 100 kilograms of molecular hydrogen aloft in liquid form, then inject it a point 50 to 100 kilometers below the F2 layer, since the hydrogen will diffuse upward.

Carried out at night, the astronomers calculate, such an injection ought to produce a window in the shape of a vertical tube about 200 kilometers across and perhaps 1,000 kilometers high. As the tube forms, the free electron density should drop about 95 percent in less than half an hour, and last for several hours.

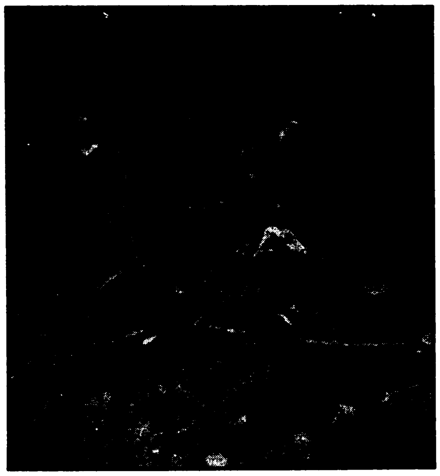
A proposal for the Arecibo test is being sent to the National Science Foundation—at NSF request—and the authors are already thinking well beyond that, to the possibility of periodic hydrogen releases in the 1980's from the space shuttle. □

A blooming desert project

Two living organisms—a desert plant and a marine mammal—have evolved the same unique capability: the production of an unusually structured and valuable oil. By exploiting this evolutionary coincidence, impoverished American Indians in the Southwest's Sonoran Desert may ensure their own economic survival and the survival of an endangered species.

This is the conclusion of a report just issued by the National Research Council. It assesses the scientific and economic feasibility of cultivating the oil-bearing desert plant as a cash crop on the Indian reservations of the Sonoran desert. This arid area stretches for hundreds of miles across southern Arizona and California, and the Indians living here, where farming is difficult and industry virtually nonexistent, are among the poorest people in the United States.

The plant is the native desert shrub jojoba (pronounced ho-HO-ba). It is a scrubby bush that sports small, leathery leaves and bears hard, brown seeds that contain 50 percent oil. Its evolutionary "cousin" is the sperm whale, the largest of the toothed whales, reaching 60 feet or more in length. Up to a ton of oil is carried in the huge spermaceti organ in the animal's gigantic head. It is not yet known what carrying around a one-ton spermaceti organ does for the whale, although there are some guesses. Some think it might function as an acoustic lens for picking up the whale's self-made sonar readings. Some say the organ may help generate the sonar "clicks" themselves. And others believe the oil may be an efficient nitrogen absorber and help prevent the "bends." But one thing is known for sure about the spermaceti organ: It contains a highly valued oil with hundreds of industrial uses. It is for this reason that the sperm whale is hunted unceasingly.



Sperm oil and jojoba oil are nearly identical structurally, but only sperm oil has been used industrially, due to its past availability and the difficulty of harvesting jojoba beans from wild desert plants spread over millions of arid acres. Both are liquid wax esters. Unlike normal animal and vegetable oils (which contain one molecule of glycerol and three molecules of fatty acids), jojoba and sperm oils contain one molecule of a long-chain alcohol and one molecule of a long-chain fatty acid. This structure makes them stable over long periods of time and under extreme conditions of pressure and temperature. At the height of its availability during the late 1960's, U.S. industry used 50 to 55 million pounds of oil per year for a variety of purposes—among them, as a lubricant in automotive and tractor transmission fluids and as an additive in metal-working oils.

The United States in 1970 banned the importation of sperm oil because of the animal's endangered status. Since then, stockpiles of the precious oil have dwindled. The chemical similarity between sperm and jojoba oils has been known for 40 years, but until sperm oil importation was banned, there was little incentive for development of a jojoba-based agriculture. Indians, in need of an economic base within their reservations, have been interested for years in developing jojoba, and in the summer of 1972 harvested 87,000 pounds of seed from wild jojoba to facilitate scientific and economic testing (SN: 7/14/73, p. 26). The NRC jojoba committee was organized that year, headed by chemist Milton Harris, president of Harris Research Laboratories, Rockville, Md. It was charged with determining whether jojoba could be cultured on large plantations and whether Indians could reap both marketable oil and profits. The answers seem to be yes.

In addition to scientific studies on the jojoba plant, oil and wax (the hydrogenated form of the oil), the committee reviewed the initial results from three small pilot plantation projects, one at the University of California at Riverside, one at the Barona Indian Reservation and one in the Negev desert in Israel. Cultivation of the desert bush looks very promising. Because it is a native plant, it is well suited to the desert climate. It can withstand daily summer highs of 110 to 115 degrees F., and needs only about 12 inches of rainfall a year—and little or none of that in the summer. It needs a modest amount of water in the winter and spring when it is most available. After five years, a mature cultivated plant can produce on the average five pounds of seeds per year, and a plantation, the report estimates, could yield 1,000 to 2,000 pounds of oil per acre. The committee recommends that the Government subsidize the planting of 2,000 acres of cultivated jojoba, 400 acres per year for five years, and foresees a lucrative jojoba-based industry.

No one is claiming jojoba culture will definitely save the sperm whale, but it might be a modifying influence. Jojoba oil would have to be plentiful enough and priced to compete with sperm oil on foreign markets. Sperm whaling is a lucrative industry in certain countries such as Japan, and overfishing a species even to the point of extinction can remain profitable (SN: 4/19/75, p. 26).

Jojoba oil, tests show, can be used to replace sperm oil as a high-pressure lubricant, and jojoba wax has a chemical structure and properties like carnuba wax. Carnuba and other similar waxes are used in floor and paper finishes, polishes, candles, soaps and cosmetics. Jojoba oil could also become a source of straight chain unsaturated alcohols and acids used in many chemical products. And, as if the wonder bean did not have promise enough with these potential markets, a high protein meal remains after the oil is pressed out, and it contains an unusual material called simmondsin which acts as an appetite suppressant in laboratory animals. □