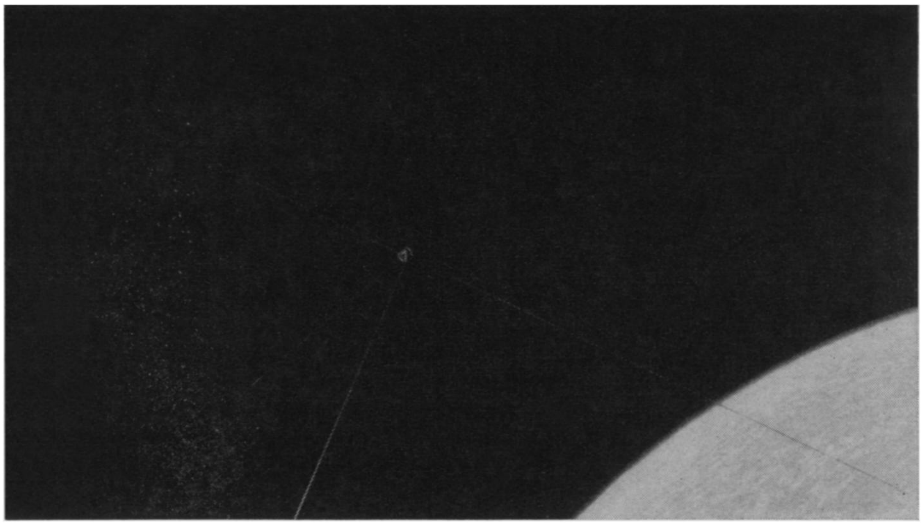
SATELLITE ASTRONOMY

Long-legged Eye in the Sky

The longest satellite ever launched, more than a quarter mile across, will open new vistas in astronomy.



NASA

Looking like a giant spider, the RAE's "legs" total 3,720 feet.

The earliest U.S. satellite launched, Vanguard 1, was the size of a moderately healthy grapefruit. The biggest satellites this country has ever launched were the Pegasus series, 96 feet across, about like the wingspread of a DC-3. Late this year, however, the National Aeronautics and Space Administration plans to launch a real whopper, which when fully deployed in space will stretch the length of five football fields.

Its name is the Radio Astronomy Explorer, and though its body is small, its antennas and other appendages will give it the appearance of an orbiting seven-legged spider. Four 750-foot antennas arranged in an X will produce 1,500-foot spans in two directions; a pair of 60-foot dipoles will stick out in other directions and a 600-foot-long stabilizing device called a nutation damper will add to the satellite's bizarre appearance.

The Explorer's huge spans will enable radio astronomers to investigate wavelengths longer than they have ever observed before. Devices to detect frequencies over 10 different ranges up to 10 megacycles will provide scientists with almost more data than they can handle, while an ion probe, a plasma probe and other instruments send back information on the satellite's environment.

The satellite will be oriented with two of its 750-foot antennas pointing in toward earth and the other two away from it. "Its job will be to make kind of a coarse map of the galaxy," says Frank Gaetano, NASA's assistant program manager for the Explorer series. In addition, it will be looking at, or rather listening to, a number of specific targets, including Jupiter, from which scientists have already detected radio waves; the sun; constellations such as Cygnus and even the earth itself.

In the future, NASA plans to launch a second Radio Astronomer Explorer, enabling the pair of satellites to be used as an interferometer. This would in effect be the same as launching a single huge telescope equal in size to the distance between the satellites, which could be many miles. This would enable great accuracy in pinpointing the sources of long-wavelength radio emissions. The space agency has discussed plans for launching as many as six similar satellites.

The initial satellite itself, including the antennas and the small kick rocket that will be used to maneuver it into its 3,800-mile-high circular polar orbit, weighs some 600 pounds, about the same as the Surveyor robot mooncraft. The antennas account for about one-eighth of the total weight, while a considerably larger portion is taken up by the solar cells that will provide the Explorer with the 22 watts of power it will need. "The design lifetime is about a year," says Gaetano, "but anything we get will be a valuable first."

The biggest "firsts," and also the source of many of the satellite's developmental problems in the past, are the antennas. Made of foil-thin, 0.002-inch beryllium-copper alloy, they are ingeniously designed in the form of rolls of pre-stressed strips, designed to form automatically into half-inch tubes as they are unreeled. The 750-foot antennas can each be stored on reels less than half a foot in diameter.

Where do you test a flimsy antenna span of 1,500 feet? The answer, as NASA found out, is that you don't. Because the antennas are so frail, they had to be tested for proper deployment in some place with no unwanted air currents, which is to say, indoors. The largest indoor facility NASA could find was the high-speed ballistic test chamber at the U.S. Naval Ordnance Laboratory, White Oak, Md. There, in a 1,000-foot water-filled trough, a precisely-placed line of buoys was topped with small rings through which NASA tested the accuracy of the antenna-deploying system, using only a single, 750-foot span.

But that was not the only antenna headache in the works. Since they are so long, they will be subject to bending in space due to gravity, the solar wind, changes in temperature, perhaps even the motion of the satellite.

A polar orbit was selected largely because it would provide almost a year of uninterrupted sunlight before sliding into the earth's shadow, when uneven cooling will inevitably bend the antennas. This case of the bends will not severely hamper their efficiency, for two television cameras will be keeping 24-hour-a-day watch on them so that scientists will know how to compensate when decoding the satellite's astronomical reports.

Another job of the cameras will be to watch the tips of the antennas as they are being deployed. The motion of the unreeling antennas could affect the orientation of the satellite, and since the satellite will have no system of attitude control thrustors, the antennas will have to be deployed gingerly, a little at a time. Tests of small (42-foot) antenna segments have already been made in the vacuum chamber at NASA's Goddard Space Flight Center, where the satellite is being built, to see how the tips might move around in space.

Despite its elaborate antenna system, however, the Radio Astronomy Explorer is much less complicated than many past satellites, such as the Orbiting Geophysical Observatories, and it thus stands a good chance of success. As with optical astronomy, radio astronomy must sooner or later move into space to escape earth's atmospheric blanket, which completely prevents many wavelengths from ever reaching ground-based telescopes. NASA is already planning large telescopes to be constructed on the moon, which combines freedom from atmospheric interference with the stability of a solid footing and only one-sixth of the gravity which on earth makes distortion of large mirrors and antennas a severe problem.