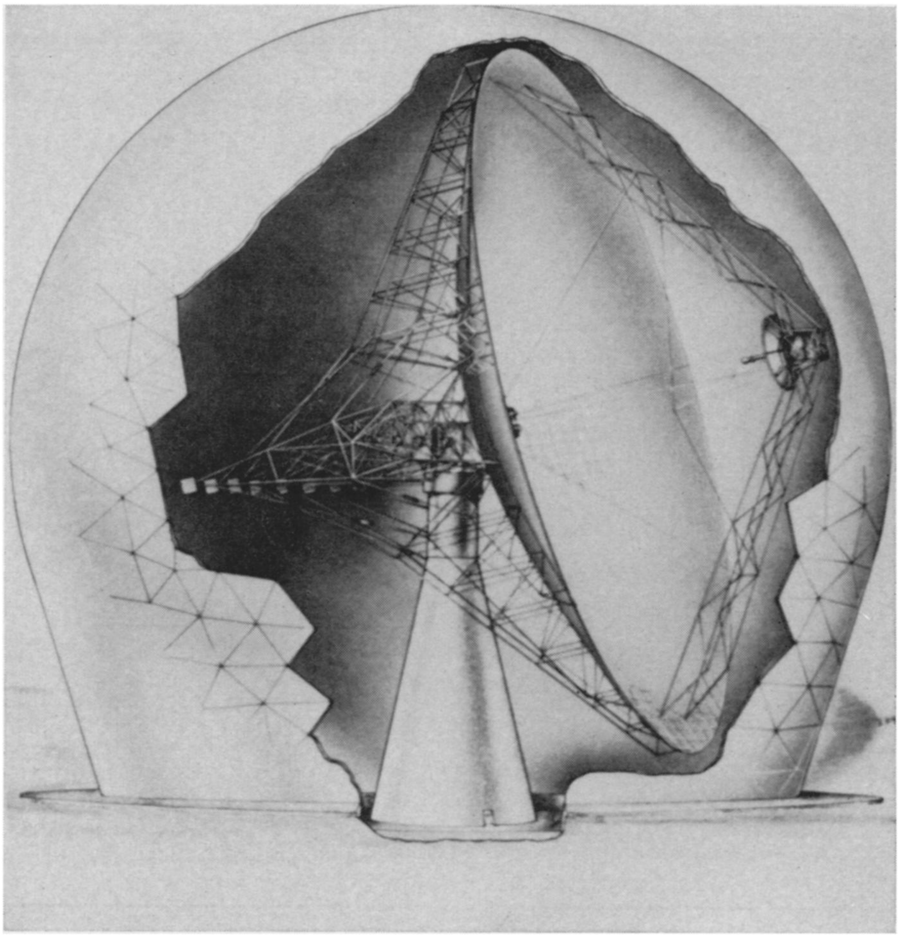
ASTRONOMY

New radio telescopes

Budget problems caused a virtual cessation of new construction a few years ago; now life is returning to old projects

by Dietrick E. Thomsen



The Washington Star

Alive again: Radome-covered radio telescope NEROC would like to build.

In the last 30 years radio telescopes have given astronomers an entirely new picture of the universe. Radio astronomy has a distinguished record of discovering things not only unknown, but unsuspected. The record stretches from the original discovery in the 1930's that astronomical objects gave off radio waves (SNL: 6/3/33, p. 389), to today's excitements, quasars and pulsars. Radio observation has given scientists views of parts of the universe that are blocked to human sight by opaque dust clouds. It has charted the motions of interstellar gas clouds and determined their chemical composition. And much radio astronomical work has been right in the middle of the most fundamental of sciences, cosmology, the study of the origin and history of the universe.

As their science has progressed, radio astronomers have wished to see both farther into the universe and finer and finer detail. To accomplish these purposes they have built larger and larger telescopes. Until the early 1960's they were supported in this endeavor by various countries, notably the American, Australian, British and French Governments.

Then just about everything stopped. The reasons were mainly budgetary: The largest of projected modern radio telescopes run into the tens of millions of dollars. Compared with the latest in particle accelerators, which run 10 times that, the price of a radio telescope is hardly astronomical, but radio astronomy has never touched public hopes and fears the way nuclear and particle physics have done. Furthermore, it is fair to say that particle physicists have also been having money troubles in recent years.

During the years of what the journal NATURE has called "the hiatus in radio telescope construction," concern over the future of radio astronomy has become more and more intense. Now at last there are signs of a new spring. A steerable radio telescope larger than any now existing is under construction in West Germany and long dormant British and American projects are showing new life.

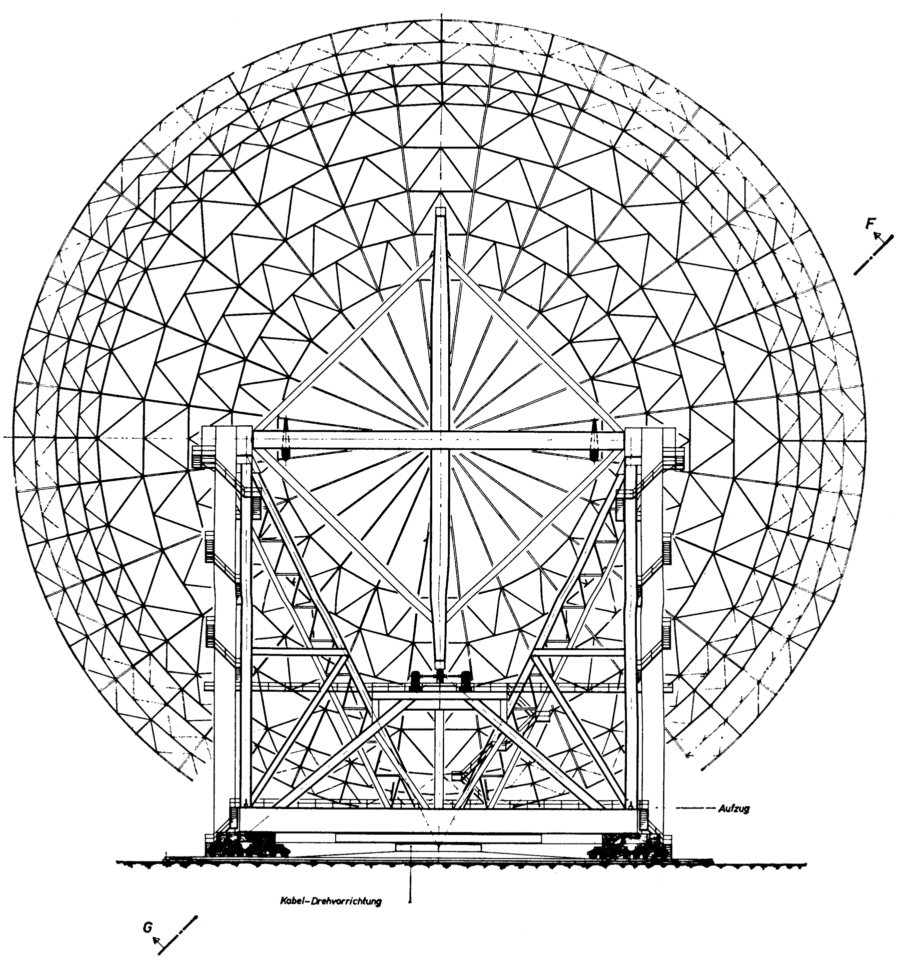
There are two ways to see finer detail, that is, to gain higher resolution of the telescope images. One is to build very large single dish antennas. The other is to build an array of small ones whose signals are combined so as to simulate the signal from a single antenna as large as the widest extent of the array.

Arrays can thus be used to simulate single antennas larger than could ever be built, but they pay for this advantage by slow data gathering, ponderous difficulties in pointing and severe limitations on the wavelengths they can receive. Single dishes are superior in pointing, tracking and switching among wavelengths, and remain the focus of astronomers' ambitions.

The current generation of largest fully steerable single radio telescopes are all just over 200 feet in diameter: a 250-foot dish at Jodrell Bank in England, a 210-foot one at Parkes, Australia and another 210-foot one at Goldstone, Calif. A few single dishes larger than these do exist, but they are not fully steerable and their application is thus severely limited.

The current crop of large radio telescopes were all completed in the early 1960's. At the time radio astronomers were already projecting their next steps. But nothing further was done. A projected 600-foot fully steerable dish at Sugar Grove, W. Va., on which some work had already been done, was abruptly dropped.

In 1964 a board convened by the U.S. National Academy of Sciences recommended a quick start on a national radio telescope of 300-foot diameter or greater. If the advice had been taken when it was given, the telescope



German 330-foot steerable dish, being built, will be the world's largest.

could have been built by now. But the money wasn't there.

Then in 1967 another committee of scientists under the chairmanship of Dr. Robert H. Dicke of Princeton University took a look at currently mooted large radio telescope projects to recommend to the National Science Foundation a rock bottom program which might have some chance to get funded.

The Dicke committee recommended one large dish and two large arrays. The arrays were to be at Owens Valley, Calif., and Green Bank, W. Va. The single dish was to be the so-called NEROC, that is, New England Radio Observatory Committee, a consortium of institutions in the Northeast. The committee also recommended resurfacing the 1,000-foot non-steerable dish at Arecibo, Puerto Rico, in order to increase its capabilities, especially at short wavelengths, where increased accuracy of the surface shape is necessary for accurate reflection.

This year two of these projects are showing some life. The NSF has included the money for resurfacing Arecibo in its fiscal 1970 budget and awaits Congressional approval to start the work. But though the foundation has given some money for NEROC, it is not able to get any more, and this year NEROC is going through the Smithsonian Institution instead. The Smithsonian is a member of NEROC and seems to be better able to get money from Congress than the NSF.

The Smithsonian directors have approved a request for $2 million to plan the NEROC telescope, and three Smithsonian directors who are also U.S. Senators, Clinton P. Anderson (D-N.M.), J. W. Fulbright (D-Ark.) and Hugh Scott (R-Pa.), have introduced a bill to authorize the amount.

The bill is now in committee. If it passes, planning the telescope is expected to take two years. If money is then forthcoming for construction, five more years would be needed for that. Total cost for the telescope would be about $40 million.

Preliminary studies have given the New England Committee a good idea of the sort of telescope it wants. It envisions a 440-foot paraboloid housed in a radome to protect it from the weather. Such protection would lower construction costs considerably. The telescope envisioned would be a broadband device capable of receiving with high precision at all wavelengths from 5 to 300 centimeters. Its steering would be good enough to point it with an accuracy of 0.003 degree.

. . . astronomers' antennas

In Britain, planning for a 400-foot dish at Jodrell Bank (SN: 5/13/67, p. 450), has been underway for some time, but no one has yet talked about breaking ground. Meanwhile, at Cambridge University's Mullard Observatory, construction will begin on a somewhat more modest project, a five kilometer array of 42-foot antennas.

The five-kilometer array has been designed to extend one of the programs now being carried out with a similar one-mile array: a detailed study of quasars that hopes to gain information about the physical processes going on inside them. The one-mile instrument can make radio maps of the sky that separate features as close together as 20 seconds of arc (1/180 degree), but astronomers are finding that interesting quasar detail demands finer resolution than this. The five kilometer array is intended to provide detail as fine as one or two seconds of arc. It will be built along an abandoned rail line that borders the property owned by the Mullard Observatory.

Four of the aerials will be fixed in place. The other four will be mounted on trucks that will run on a special track 28 feet wide and three-quarters of a mile long. The movable aerials will be positioned within an accuracy of one millimeter at a number of predetermined locations. The array will operate at two frequencies, 2.7 gigahertz and 5.0 gigahertz.

It will cost about $5 million and take about three years to build.

The German telescope, being built in Munstereifel, near Bonn (SN: 4/19, p. 386), is expected to be finished by June 1970. It will conduct radio line spectroscopy in the centimeter wave region for two major purposes: a study of interstellar hydrogen clouds in the hope of gaining information on the part they play in the origin of stars, and studies of quasars and radio galaxies that are indistinguishable with present telescopes. Study of their spectra at centimeter wavelengths with the new instrument may show up distinguishing features. The question of how these bodies generate the enormous energy they radiate is one of the most important in present-day cosmology and astrophysics.

The West Germans have some other small radio telescopes, but the 330-foot is their first really large effort in the field. They are building it now because they feel that their postwar reconstruction is fairly over and they can afford to divert large sums to science (SN: 3/8, p. 246). The telescope will cost about $10 million, most of which is being provided by the Volkswagen Foundation. ◇