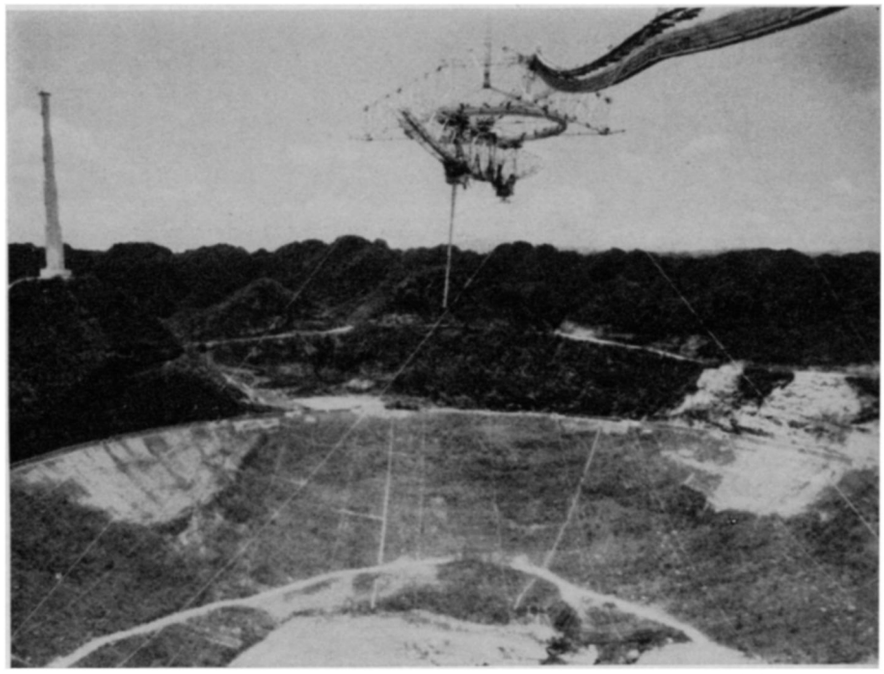
Hard Choice or Astronomers

Scientists opt for upgrading Arecibo and steerable array as next leap forward.



Gilbert and Bennet

The 1,000-foot Arecibo radio telescope, with its pickup 500 feet above

The recent dicovery of radio waves being emitted by certain molecules and atoms, and of the almost inconceivable amounts of energy generated by quasars, has opened new vistas in radio astronomy and astrophysics.

Technological advances now make possible a giant stride forward in the capabilities of detecting faint radio emissions from the universe, and scientists are poised to take that stride.

To evaluate five major proposals taking advantage of the new capabilities, the National Science Foundation in June appointed an eight-member Advisory Panel for Large Radio Astronomy Facilities, a supplement to its standing advisory group. The panel's evaluations were issued Aug. 22, so the proposals and recommendations could be discussed at the International Astronomical Union Assembly in Prague.

The report forms a blueprint for progress in radio astronomy during the next decade. It stresses that, as in all other fields, money spent on scientific research is not only closely scrutinized but must be carefully justified.

Expensive laboratories that cost millions of dollars to build and maintain are considered a national resource and, therefore, should be made available to all qualified scientists, whether or not they are connected with the institution administering the facility.

Since very large radio telescopes, such as the five evaluated, "present such unusual research opportunities and are so expensive," the panel strongly recommended that at least 50 percent of the observing time at such facilities be made available to any qualified scientist. This is seen as a step toward a truly national radio observatory.

Although the National Radio Astronomy Observatory at Green Bank, W. Va., has that designation, its research program is determined mainly by the nine-member Associated Universities, Inc., whose members include Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania, Princeton, Rochester and Yale.

Many scientists now believe that all expensive Government-supported facilities, whether for optical or radio astronomy, or for high energy physics, should be available to those with the most challenging observational programs, regardless of their affiliation and such broad-availability requirements as this are likely to become more and more common.

If all of the proposals for radio telescopes evaluated by the panel had been adopted, the cost would have been only $115 million, less than the price of two day's war in Vietnam. However, mainly because of budget limitations but also because of some scientific and technical considerations, the panel recommended proceeding immediately with only two of the five proposals it had under consideration, at a cost of $20 million.

Of this, $1.7 million has already been granted to the California Institute of Technology for building the first of a proposed array of eight antennas, each 130 feet in diameter. The panel's first recommendation was to proceed with completion of the array "as soon as possible."

The seven antennas to be constructed in Owens Valley, Calif., under the aegis of California Institute of Technology at an estimated cost of $15 million, would be linked to the one now nearing completion there. The eight dishes would move along tracks laid out in the shape of a letter "T," with an east-west dimension of 9,000 feet and a north-south length of 16,000 feet.

The panel's second recommendation was for "upgrading the 1,000-foot spherical dish in Arecibo, Puerto Rico, to permit observations at 10 centimeter wavelengths or shorter." The antenna, which is built into a natural hollow, was originally constructed for ionospheric studies at wavelengths of 50 centimeters and longer.

Operational experience and measurements made over the last few years indicate that the elevated antenna feed and the dish structure are so stable that improvement of the surface for use at shorter wavelengths is feasible. The proposed improvements include replacing the present wire mesh surface of the dish with a surface of solid or nearly solid construction and the installation of new feed systems.

The modifications, costing about $3 million, would make the antenna, now the world's largest in terms of collecting surface, the most sensitive partially steerable radio telescope in the world.

The panel urged that definitive studies be made "directed toward assessing the potential of large, fixed spherical dishes with multiple feeds (the Arecibo type),

since this approach may lead to instruments of the largest collecting area."

Deferred, except for design studies, were proposals for a very large array of 36 dishes in a pattern 13 miles on a leg by the National Radio Astronomy Observatory (SN: 2/25) and a fully steerable 440-foot-dish, housed in a radome, proposed by the North East Radio Observatory Corporation (SN: 12/31/66).

Declined, partly because of funding problems, was the proposal by the California Institute of Technology for the Associates in Radio Astronomy to fund the design of a conventional 330-foot steerable antenna, bigger by 80 feet than any now in operation. However, the panel noted that if it were not "for the revolutionary possibilities inherent in the Arecibo and NEROC for going to much larger dishes at moderate costs, the ARA proposal would be attractive."

The panel says it is "convinced that, except for the problems of funding, the scientific needs would amply justify the construction of several steerable antennas simultaneously."

Two basic types of facilities were proposed: individual large dish-shaped reflectors, steerable to allow the antenna to track an object during its apparent motion across the sky, and arrays of smaller dishes, also steerable, tied together by complex electronic equipment. The two types complement each other and have different functions.

In general, large arrays are able to achieve the high degree of resolution needed for obtaining radio pictures of distant celestial sources, such as galaxies and quasars. Large single antennas are especially effective in conducting detailed studies of the radio energy emitted by various chemical elements in hot gaseous clouds.

The proposals reviewed by the panel were for types of facilities recommended by a 1964 National Academy of Sciences report, known as the Whitford Report, calling for such construction in order to help put the United States in the forefront of radio astronomical research.

Dr. Robert H. Dicke of Princeton University was chairman of the panel, which had two optical astronomers as members: Dr. Bart J. Bok, director of the University of Arizona's Steward Observatory, and Dr. W. W. Morgan, former director of Yerkes Observatory.

Dr. Dicke says he is particularly pleased to have had the advice of the two optical astronomers because of his belief that optical and radio astronomy will draw closer together with time.

Other members of the panel included Drs. Rudolph Kompfner of Bell Telephone Laboratories, Merle A. Tuve of Carnegie Institution of Washington, Gart Westerhout of the Universitv of Maryland, Stirling A. Colgate of New Mexico Institute of Mining and Technology and Eugene N. Parker of the University of Chicago. ◈

ASTRONOMY

International Astronomical Union

Some 1,000 scientists who specialize in observing space and the objects it contains, both near and unimaginably far away from earth, gathered in Prague last week for the 11-day Thirteenth General Assembly of the International Astronomical Union.

They came from around the world to discuss such earth-oriented matters as how to keep time and the night-sky glow and such astronomical factors as binary stars and the formation of the universe.

As representatives of 43 nations, the scientists met in some 34 different commissions whose recommendations were approved at the final plenary session on Aug. 31. The preliminary "Agenda and Draft Reports" for the IAU Assembly, on which the discussions and recommendations were based, ran to 1,143 pages.

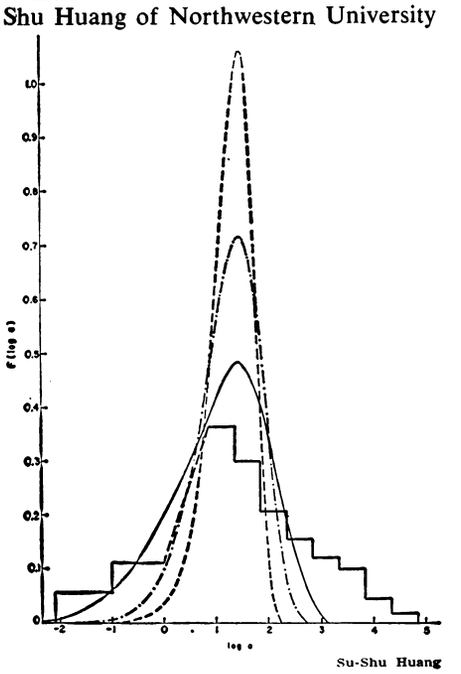
The feasibility of transporting clocks by air to make microsecond comparisons between standard clocks in widely separated locations was first demonstrated several years ago. Since then, a number of quartz and cesium clocks have been used to make precise comparisons of time between selected pairs of establishments, not only within the United States and Europe, and between the two continents, but among 25 establishments in 12 different countries in 1966, with a repeat of the standardization scheduled for this fall.

The IAU Commission on Time (No. 31) was told that satellites can now be used to synchronize far-separated clocks without the necessity of physically moving them. Drs. William Markowitz and C. A. Lidback of the U.S. Naval Observatory in Washington, with Drs. H. Uyeda and K. Muramatsu of the Radio Research Laboratories in Tokyo, successfully used the NASA communications satellite, Relay II, to verify synchronization of two cesium atomic clocks between the U.S. and Japan to within one-hundredth of a microsecond. (Dr. Markowitz is now at Marquette University, Milwaukee.)

The IAU noted that there has been a recent polarization of interest in the night-sky glow by geophysicists, whereas years ago only astronomers troubled themselves about this subdued background light. Although astronomers are still interested because the night glow constitutes a "haze" through which they must see, Commission 21 predicted that the growth of astronomy from spacecraft above the night glow means this soft light will come to be more and more associated with geophysics, at least until data concerning atmospheric radiations of other planets are available.

Geophysicists are interested because studies of night-sky glow indicate the chemical reactions taking place in the high atmosphere.

According to various studies, more than one-half of the stars exist as members of binary and multiple systems. Therefore, any theory of star formation must account for this fact. Dr. Su-Shu Huang of Northwestern University



Distribution of binary stars according to (in descending order), previous theory of star formation, Dr. Huang's first theory, Dr. Huang's revised theory of binary formation from one initial consideration (solid curve)—much closer to the observed distribution, shown by the stepped line.

reported to Commission 42 that his theoretical calculations had shown that there are two distinct processes by which binary stars can be formed, and that his theoretical results agree with observations.

One method of formation is from a single initial condensation eddy in the interstellar gas and dust that then splits into two sections. The other method of formation is from two initially sep-