National Radio Astronomy Observatory
Green Bank, West Virginia

Quarterly Report

July 1 - September 30, 1963

RESEARCH PROGRAMS

85-foot Telescope

The main uses of the 85-foot telescope during the quarter have been (a) the testing of the Jasik feed system, (b) a program of gain measurements of the dish at various frequencies, and (c) the first installation and test of the 5000 Mc travelling wave maser. About 100 hours of observing time were used for (a) and (b) and about 170 hours for (c).

(a) Tests of the Jasik feed. (Electronics Division Internal Report No. 12.) A research and development program has been carried out at the Jasik Laboratories to design a feed which would so illuminate a parabolic dish that the total antenna temperature would be reduced and the gain increased. Such a feed, working at 1420 Mc, was built by Jasik and tested at NRAO by P. Mezger on the 85-foot telescope. The tests showed that the feed did in fact reduce the antenna temperature by about the amount anticipated, but did not provide the expected increase in aperture efficiency over that obtained with a well-designed horn feed. The latter result is not well-understood.

(b) The gain of the 85-foot. (Electronics Division Internal Report No. 17.) Mezger also measured the gain of the 85-foot and used his and other measurements, together with the photogrammetric measures of the surface of the antenna, to test the relationship between gain and surface accuracy. He showed that the formulae of Ruze and others can be satisfactorily applied in practice to relate gain to surface irregularities.

(c) The 5000 Mc maser. The maser was installed on the telescope after a lengthy period of laboratory tests. Although some quite satisfactory runs have been obtained, showing good stability and adequately low noise temperatures, problems with the maser cryogenics have been encountered, such as occasional rapid boil-off of helium, and no useful radio astronomy observations have yet been made.

300-foot Telescope

	Hours
Hours scheduled	1995
Equipment installation and calibration	93
Time lost due to equipment failure, interference and weather	162
Maintenance	49

The scheduled programs were:

	Hours
(a) Department of Terrestrial Magnetism hydrogen line observations on M31, M33, and M81	1043
(b) Extragalactic hydrogen line observations	952

The extragalactic hydrogen line observations were made by Dr. Morton Roberts, of Harvard, using the NRAO 20-channel receiver built by Dr. B. Höglund. Dr. Roberts was able to extend considerably his earlier observations of hydrogen in other galaxies, which are described in the Scientific American for June 1963.

The Millimeter Wave Program

A new observing location near the laboratory has been developed for the millimeter wave telescopes. The original 5-foot dish has been remounted at this site on a new mount, and a 36-inch mirror, capable of being used at 10 microns, is also available. A 12-foot spun-cast dish will soon be delivered, and a surplus Nike mount has been modified to carry it.

Dr. F. J. Low has made observations using his bolometer at 10 microns, using the 82-inch telescope at the McDonald Observatory, of the Moon, Saturn, Jupiter, and a number of stars. At Green Bank the 5-foot, with the Low bolometer, has been used to observe the Moon at 1.2 mms, and the first observations of the planet Jupiter at these wavelengths have been made.

EQUIPMENT DEVELOPMENT

The eight standard receivers for the multiple feed system on the 300-foot telescope have been completed. Five of these receivers work on 1420 Mc and three work on 750 Mc.

Three standard receivers for the occultation project are 50 percent complete. Parametric amplifiers and feeds for the system have been ordered. Estimated completion date is January 1, 1964.

Several major components for the autocorrelation receiver have been ordered. Delivery is expected in October 1963. The correlation logic has been designed and successfully tested using 3C modules. Design of output logic has been started. Estimated completion date for the autocorrelation system is January 15, 1964.

The 20-channel hydrogen line receiver was installed on the 300-foot telescope. A parametric amplifier-tunnel diode front end combination was used.

The 5000 Mc maser was tested on the 85-foot telescope. The electronic parts of the system worked well, but the helium dewar showed signs of vacuum leaks and mechanical deficiencies causing erratic and very rapid helium boil-off. Repair or replacement of the dewar is necessary before useful operation of the maser can be expected.

Electronic scanners have been built and installed at the 40-foot telescope.

The back-up digital position indicator for the 300-foot telescope is completed and will be installed in the beginning of October.

A digital position indicating system for the 12-foot millimeter wave telescope is 50 percent complete. Estimated completion date is October 25, 1963.

The 5000 Mc TRG low noise feed was tested on the 85-foot telescope with good results. Similar feeds will be used for the 85-foot interferometer.

A receiver for the West Eprd project has been assembled and tested.

The design of the electronic system for the 85-foot interferometer is about 60 percent complete.

Attached as Appendix A is a list of the internal reports issued by the Electronics Division during the report period.

CONSTRUCTION

Blaw-Knox will start delivery of the supporting structure of the new 85-foot telescope (interferometer project) on October 10. The concrete foundations for the first observing station are complete. Concrete is being poured for the foundations at observing station No. 2; the bedrock is being keyed out at station No. 3; and excavation is underway at station No. 4. The contractor has placed about 50 percent of the run-of-bank crushed stone for the roadways. Invitations to bid on the control wiring system for the interferometer were sent out on September 25, and an award will be made on October 11.

Most of the concrete floor of the new warehouse building has been poured, and electrical work is in progress. Roads, sewers, and electrical ducts outside the building are now being constructed. It is hoped to have this building ready for occupancy by November 15.

Construction of a 2000 foot grass airstrip on Observatory property, adjacent to the Laboratory building, is now completed. Several airplanes have used the airstrip and found it quite satisfactory.

Progress on the 140-foot telescope is following fairly well the schedule outlined in the previous quarterly report. The major welding of the aluminum superstructure is complete, and work has been started in the assembly and welding of the yoke structure. The first phase of tests of the drive and control system has been satisfactorily completed. The second phase tests have been conducted and were satisfactory except for one failure which is being rectified. The third and final phase of the tests will be carried out fairly soon, and, if these are satisfactory, the whole system will be delivered to the Observatory. It will, of course, be available well in advance of the scheduled time for its incorporation onto the telescope.

ANTENNA DESIGN STUDIES

Parabolic antennas

No further contracts have been arranged for antenna design studies. The design of a 400-foot transit telescope by Rohr has been studied at NRAO sufficiently for first cost estimates to be made. There is a considerable concensus of opinion among radio astronomers outside the NRAO that another transit telescope is not the ideal next step for the Observatory. Further discussions of these views are taking place, with the hope that by the early spring of 1964 an agreed plan can be made for the next large parabolic dish at the Observatory.

Work proceeds on the study of a 300-foot Cassegrain design at TRG, and on a study at Lear Siegler, Inc., of the cost of parabolic dishes as a function of various parameters.

Array antennas

(i) The interferometer studies

Much of the work on the design of the two-element interferometer which has been carried out (Electronics Division Internal Reports Nos. 14 and 19) is of interest in the design of large arrays for radio astronomy. A study has been made of the expected performance of the interferometer by calculating the response of the instrument, both to the presently known intensity distributions of some of the stronger radio sources and to the known intensities of many weaker sources.

(ii) Related work directed towards a very large antenna

The experiment, in which the variations of the phase path of radio waves propagated over the ground is measured, has now been operating since July. A frequency of 5.6 kMc (5.4 cms wavelength) is transmitted over two horizontal paths, each representing a 600 meter go and return length, to reflectors 300 meters on opposite sides of a central recording point. Changes in phase path length of each path and differential changes between the two paths are recorded. The experiment has already confirmed that over a single 600 meter long path the phase changes are so great that if the path were being used to send local oscillator signals to a distant antenna serious phase errors would result. Even the differential phase over the two equal paths shows changes of up to 30°. The experiment will be continued to study the statistical properties of the phase changes and to relate these changes to atmospheric conditions. The experiment was planned to find the limits of phase stability which could be expected for uncompensated paths, to provide information about the phase changes in case it was decided to design a compensated path radio link, and to test whether measurements over the ground might be related to phase path fluctuations through the atmosphere which can limit the performance of a high resolution interferometer.

Another single experiment which is being carried out both for the large antenna and for the millimeter wave program is the measurement of the total water vapor content of the atmosphere between the earth and the sun. A simple infrared detector follows the sun, and the signals received within and just outside a water vapor absorption band are compared. The equipment works well and, since total water vapor is important both for millimeter waves and for the performance of a

very large antenna, the device may prove useful for the early stages of site testing for such instruments.

RADIO NOISE AT NRAO

A program has been started to measure or estimate the degree of radio disturbance at present being experienced at the Observatory from automotive interference. The program will also estimate how the interference might be expected to grow in the future if the patterns of traffic near NRAO change and will cover a consideration of possible changed locations for some roads in the vicinity.

The general plan of the program has been worked out, and two companies, Tippetts, Abbett, McCarthy, and Stratton, of New York, and the Frederick Research Corporation, of Maryland, have been chosen to cooperate in the work.

PERSONNEL

Dr. T. K. Menon, from the Ohio State University, joined the Research Group as Associate Scientist on August 19.

Dr. Rama C. Menon, from the Ohio State University, joined the Electronics Division staff as Research Associate on September 1.

Mr. William Burns, of the Carnegie Institute of Technology, and Mr. Marvin DeJong, of Rensselaer Polytechnic Institute, are each spending a year at the Observatory doing their thesis work.

Dr. Frank D. Drake was granted a one year's leave from the Observatory on September 6, so that he could go to the Jet Propulsion Laboratory, where he has assumed the position as Chief, Lunar and Planetary Sciences Section.

Mr. V. R. Venugopal, of the Nizamiah Observatory, Deccan, India, ended a one year appointment as Research Associate in the Research Group on July 15. He is at the University of California, where he received a research assistantship in the Department of Astronomy.

THE XIV GENERAL ASSEMBLY OF URSI

Dr. Heeschen, Dr. Findlay, and Dr. Mezger (who was a member of the German delegation) attended the meeting of the International Union for Scientific Radio in Tokyo from September 9 - 20. In addition to holding several scientific sessions, Commission V on radio astronomy appointed a committee headed by Dr. J. G. Bolton of Australia to consider the formation of an international radio astronomical facility. From the USA, Dr. John Hagen and Dr. Findlay were appointed to this committee.

Appendix A

No	Title	Author	Date-1963
11	Standard Receiver Assembly, Components and Cost	C. Wooddell	July
12	The Characteristics of the 85-foot Telescope at 21 cm Wavelengths with a Horn Feed and a Compound Dipole Feed	P. Mezger	July
13	A Solid-State Radiometer	J. Dolan	August
14	Design Considerations for the NRAO Interferometer	N. Keen	August
15	Some Vehicle Ignition Measurements	J. Dolan	August
16	The Measurement of the Diameters of Radio Sources with Pencil Beam Antennas	P. Mezger and P. Stumpff	August
17	Application of the Antenna Tolerance Theory to the NRAO 85-foot and 300-foot Telescopes	P. Mezger	August
18	Possible Designs for a Very Large Array of Antennas	N. Keen	September
19	A Prototype Digital Cross-Correlator for the NRAO Interferometer	N. Keen	September
20	The 20-Channel Extra-Galactic Hydrogen Line Receiver	B. Höglund	September