NATIONAL RADIO ASTRONOMY OBSERVATORY

Charlottesville, Virginia

Quarterly Report

January 1 - March 31, 1967

RESEARCH PROGRAMS

Interferometer (three 85-foot telescopes)

During this quarter the central control building was completed and much of the electronics equipment has been moved in, connected, and tested. Pointing checks and other calibration and testing have been done with 85-1 and 85-2. A two-element interferometer test run has also been made. The third element of the interferometer system, 85-3, is currently being instrumented by NRAO personnel.

300-foot Telescope

		Hours
Scheduled observing		882.25
Scheduled maintenance		383.50
Time lost due to:	equipment failure	29.50
	interference	2.25
	power	0.00
	weather	25.25

The large number of hours of scheduled maintenance was mainly used to complete the rolling and resetting of the 300-foot surface panels. Antenna evaluation measurements undertaken by M. Davis show the telescope to have an aperture efficiency of about 32% at 1414 MHz.

In the meantime, M. Davis has used the antenna at 1414 MHz and 750 MHz to continue verification of his Dwingeloo finding list of radio sources. I. Pauliny-Toth and K. Kellermann used the 1414 MHz and 750 MHz equipment to make flux measurements of sources. I. Pauliny-Toth and K. Kellermann also measured the fluxes of sources at 405 MHz. S. Goldstein (University of Virginia), observing at 142.5 MHz and using the NRAO autocorrelation receiver, attempted to observe fringes in the spectra of sources caused by linear polarization of the sources and Faraday rotation in the intervening medium.

140-foot Telescope

		Hours
Scheduled observing		1764.00
Scheduled maintenance		172.75
Time lost due to:	equipment failure	202.50
	interference	0.25
	power	20.00
	weather	51.75

The time lost due to power is not attributable to power failure itself, but it is the time required for cryogenic 6-cm equipment to stabilize as a result of short power outages.

Two very long baseline observations at 610 MHz were scheduled during this quarter, with the 140-foot and the 1000-foot at Arecibo, Puerto Rico being the two interferometer elements. These measurements in Green Bank were made by K. Kellermann and B. Clark.

Observations of lunar occultations of sources were made by J. Taylor (Harvard University) and J. Sutton (Arecibo Ionospheric Observatory) at 234, 256, and 405 MHz.

At 15.375 GHz, I. Pauliny-Toth and K. Kellermann observed the flux densities of variable sources.

Line Observations	Observers
He 109α	P. Palmer (Harvard), B. Zuckerman (Harvard), P. Mezger
H 109α	B. Burke (MIT), P. Mezger
H 137β	P. Palmer (Harvard), B. Zuckerman (Harvard)
H 173α	P. Palmer (Harvard), B. Zuckerman (Harvard)

Continuum Observations (6-cm)	Observers
Mapping HII regions in conjunction with line measurements	P. Mezger
Mapping radio continuum fluxes from HII regions to correlate the radio flux with the optical emission in the hydrogen lines Hα and Hβ for the purpose of determining the amount of optical absorption in front of those objects.	W. Gebel (U. of Wisconsin)

Continuum Observations (6-cm)	Observers
Extinction and refraction based on lunar observations	W. Altenhoff
Flux measurements of selected sources	Z. Turlo
Flux and polarization measurements of selected sources	J. Hollinger (NRL)
Flux measurements, selected galaxies	D. Heeschen
Flux measurements, Scorpius X-ray source	H. Johnson (Lockheed Missile & Space Research Center), D. Hogg

Additionally, P. Mezger, J. Schraml, W. Altenhoff, and Z. Turlo used the 6-cm system further to evaluate the telescope and observing techniques.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

During the past quarter the manpower assignments within the Electronics Division have been divided among the following programs:

Three-Element Interferometer Construction	50%
New Autocorrelation Receiver	10%
Interference Protection	4%
New Standard Receivers	5%
Millimeter Receiver Development	6%
Visitor Support and Routine Maintenance	16%
Planning of New Programs	3%
Very Long Baseline Interferometer	6%

The construction of the interferometer electronics system has been completed, and the system is now being tested and debugged. Successful operation of one of the three antennas has been obtained.

The 416-channel autocorrelation receiver is now in an intensive construction phase and should be completed by summer 1967.

Radiometers at wavelengths of 75-cm, 40-cm, and 21-cm have been installed on the 300-foot telescope.

A 6-cm radiometer utilizing a closed-cycle cryogenically-cooled parametric amplifier has been installed on the 140-foot telescope and is giving excellent results. This system has the first cryogenic refrigerator to be used in radio astronomy. The system noise temperature is 100°K with 180 MHz bandwidth.

The design and construction of three new systems has been started. These are:

1) A 4-radiometer system for multiple-beam, 21-cm observations on the 300-foot telescope.

2) A tunable 1-4 GHz parametric amplifier system for use in searches for new spectral lines.

3) A multi-channel wideband filter receiver which provides 40 observation channels with bandwidths of 25, 5, 1, and 0.1 MHz.

THE NRAO MILLIMETER WAVE ANTENNA

Extensive tests of the telescope have been performed during the report period. The torque required to rotate the telescope in azimuth was found to be strongly dependent on bearing temperature. The problem was eliminated by the installation of a heating system around the outer race of the azimuth bearing. On two occasions the tests of the servo system were interrupted by failure in one of the angle encoders which had to be returned to the manufacturer for repair. With these exceptions, tests performed to date indicate a performance close to the required specifications.

ANTENNA DESIGN STUDIES

The Largest Feasible Steerable Telescope

The outline of a design has been prepared by which many of the needs of the LFST could be met by a synthetic instrument. The suggested system is a linear array of five parabolic reflector antennas connected as nine interferometer pairs. The line is 225 meters long, and for each observation it is rotated in azimuth through 180 degrees in one hour. The end-product is a map of an area of sky within the beam of a single antenna to a resolution given by a 200-meter antenna.

The study paper shows that the sensitivity of the telescope for both flux density and brightness temperature would be satisfactory. The electronic complexity is not too great for the instrument to be used for line observations. First estimates of mechanical and structural considerations do not suggest any great difficulties. The suggested antenna sizes are two 25-meter and three 40-meter dishes. The cost of the instrument would clearly be considerably less than that of a filled-aperture telescope.

A start has been made in studying the design and probable performance of the 600-foot fully steerable antenna which was to have been built at Sugar Grove.

The Very Large Antenna Array Project

The major accomplishment during this period was the completion of the VLA proposal in early January. The proposal is in two volumes: I - VLA Concept and II - Systems Design. An initial run of 250 copies was produced at Green Bank and distribution started on January 19, 1967, with delivery of

the first copies to the National Science Foundation and AUI Trustees. Distribution of the first run has continued, with copies going to members of the National Science Board and the scientific community in general. Copies are not being distributed by NRAO to commercial firms.

The Clearinghouse for Federal Scientific and Technical Information in Springfield, Virginia is making secondary distribution of the proposal, which can be purchased from them for $6.

The NSF staff and the National Science Board have received formal briefings by NRAO personnel.

On February 20, 1967, D. Heeschen named G. Swenson, Jr. acting project manager. The design group is to continue about the same as earlier constituted, with D. Heeschen the acting chairman.

New personnel assigned to the VLA are: A. Burford, L. Gore, and Dr. N. Mathur, electronics engineers, and L. King, structural-mechanical engineer. Active recruiting is underway to fill critical positions in the areas of computers and antennas.

The contract with the University of Virginia for the "Local Oscillator System Design Study" was extended to cover building and testing of a prototype LO system. NRAO will furnish major components for the system, and the Electronics Division has solicited quotations for price and delivery dates of the major long-delivery items. The Electronics Division is also engaged in an investigation of cable procurement and installation procedures to see how they effect the present VLA schedule. Additional efforts are underway in the areas of local-oscillator signal distribution, I.F. signal transmission, and front-end components.

Stanford Research Institute is engaged in a "Parametric Design Study for the NRAO Very Large Array Antenna" to complement the study made earlier by RCA.

N. Mathur and D. Hogg have initiated a study of complementary arrays, i.e., arrays of different Y-shaped configurations whose combined transfer functions have better properties than those of either array alone. The study is to design pairs of arrays that will have extremely low composite side-lobe levels or that will permit adequate performance with somewhat fewer than the optimum number of antennas.

PERSONNEL

J. Findlay has been named chairman of a new planetary missions advisory group for the National Aeronautics and Space Administration. Called the Planetary Missions Board, it will advise NASA's Office of Space Science and Applications on the interdisciplinary scientific opportunities of planetary flight programs.

Scientific and Engineering Personnel Changes During the Quarter

Appointments

L. Gore	Electronics Engineer	January 9, 1967
N. Mathur	Research Associate	January 10, 1967
L. King	Structural Engineer	January 16, 1967
D. Buhl	Assistant Scientist	February 6, 1967
A. Burford	Electronics Engineer	March 15, 1967

Terminations

A. Robichaud	Electronics Engineer	February 17, 1967