NATIONAL RADIO ASTRONOMY OBSERVATORY

Charlottesville, Virginia

Quarterly Report

January 1 - March 31, 1966

RESEARCH PROGRAMS

Interferometer		Hours
Scheduled		1812.50
Equipment changes and scheduled maintenance		89.25
Time lost due to:	equipment failure	11.50
	weather	112.25
	interference	.25

The time lost due to weather is attributed to snow and ice collecting in the telescope and wind in excess of a value for their safe operation.

During this period the interferometer operated with 1200 and 1800 meter antenna spacings. The observing programs carried out are briefly described below.

Aperture Synthesis Program. Approximately 12 extended, complex sources are included in this program. These sources have now been observed at all the available spacings for the 2-element interferometer with the exception of 1900 meters. The 1900 meter station will be used in conjunction with the new 85-foot telescope (erection beginning June 15) to give the short spacings (100-1200 m) necessary for a complete synthesis.

Source Angular Size Survey. F. Bash (University of Virginia) continued a program designed to determine the angular size of a large number of radio sources for several position angles.

Source Positions. A program was initiated during this quarter aimed at determining position and angular size limits for approximately 30 quasi-stellar radio sources.

Planetary Nebulae. M. Kaftan-Kassim conducted observations of 6 planetary nebulae to determine the angular size for several position angles.

Source Occultations by the Solar Corona. The sources 3C 2 and 3C 446 were observed during their passage through the solar corona by Z. Turlo.

Phase Calibration Program. Continuation of a program to determine the phase characteristics of the interferometer from observations of a number of standard calibration sources.

Miscellaneous. Two short programs were initiated to obtain information for the planning of more extensive programs which may be undertaken with the 3-element interferometer when completed. The sources observed were W 49 (a and b) and W 51 for P. Mezger and a source in the Coma Cluster for H. Ko (Ohio State).

The individuals involved in the above programs, in addition to those listed in the individual programs, were B. Clark, D. Hogg, W. Tyler, and C. Wade.

300-foot Telescope

		Hours
Scheduled		1895.00
Equipment changes and scheduled maintenance		100.25
Time lost due to:	equipment failure	78.00
	weather	20.00
	interference	3.75

The jet engine, the exhaust of which is used to remove snow from the telescope, was used twice during this quarter. It is used as a telescope safety precaution when the telescope becomes ice loaded. The time lost due to weather is the sum of the time required for snow removal from the parabolic surface itself and time during which unsafe wind velocities occurred.

During this quarter, M. Roberts continued his measurements of neutral hydrogen in extragalactic systems.

The line receiver was removed from the telescope and systems for simultaneous observing at 1420 MHz and 750 MHz were installed. M. Davis (Leiden Observatory) observed to verify a Dwingeloo finding list of radio sources. The mapping of some normal galaxies was done by M. DeJong and C. Wade. P. Mezger mapped 3 selected regions in the galactic plane, a continuing program. M. Kaftan-Kassim observed planetary nebulae, another continuing program. J. Dickel (University of Illinois) observed M 31. H. Ko (Ohio State) mapped the Coma Cluster and other clusters of galaxies. A repetition of previous 3C observations was done by I. Pauliny-Toth and K. Kellermann to look for secular variations in the flux density of these sources.

140-foot Telescope

		Hours
Scheduled		1840.75
Equipment installation and scheduled maintenance		247.25
Time lost due to:	equipment failure	187.00
	weather	160.25

(140-foot Telescope, continued)

		Hours
Time lost due to:	interference	3.00
	power	36.00

Time lost due to weather is attributed to snow and rain which resulted in adverse observing conditions. Time lost due to power was caused by failure of a building transformer, which is used to supply power to receiving equipment and building lighting.

Observations were continued at 31.4 GHz by J. Baars to determine the effectiveness of the beam switching technique and to gain more information relative to random fluctuations of the atmosphere. I. Pauliny-Toth and K. Kellermann continued flux measurements of extragalactic sources at this frequency.

At 4.995 GHz, J. Dickel (University of Illinois) observed polarization effects of Jupiter and Venus. M. Kaftan-Kassim observed Mercury for phase variation and continued observations of planetary nebulae. P. Mezger and J. Schraml mapped 30 weak galactic sources. M. DeJong made flux density measurements of extragalactic sources. I. Pauliny-Toth and K. Kellermann made flux density measurements of discrete sources, and were joined by C. Sastry in making polarization measurements of discrete sources. G. Swenson (University of Illinois) observed M 31.

An improved 15.375 GHz system was installed on the telescope in mid-February. Mapping of the galactic center was undertaken by a group of observers from Cornell University under the direction of F. Drake (Cornell University). In addition, the atmospheric measurements by J. Baars, the flux measurements by I. Pauliny-Toth and K. Kellermann, mapping by P. Mezger and the program of planetary nebulae observations by M. Kaftan-Kassim were continued. D. Hogg attempted to measure radio emission from R. Monocerotis.

At 15.375 GHz a rather thorough telescope evaluation program was initiated by P. Mezger with several staff scientists contributing.

During the month of March, lunar occultations of radio sources were observed by S. von Hoerner, M. DeJong, and Joseph Taylor (Harvard University) at 234, 256, and 405 MHz.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

Approximately 25 to 30% of the electronics division's effort was expended on routine repair, systems installation and minor modifications of operational systems. However, an excessive number of failures of operational digital circuits occurred, requiring about 75% of the total digital group effort. A program is underway to increase the reliability of these units.

The 2-element interferometer has been operating satisfactorily with very little time lost because of equipment failure.

Construction Completed

A transistorized system for use in lunar occultation observations has been completed and installed on the 140-foot telescope. This system is designed to remain mounted on the telescope when not in use, therefore minimizing time required to activate the occultation system.

The 6 and 2 centimeter wideband tunnel diode systems were completed during this quarter. The 6 centimeter parametric amplifier, intended as a preamplifier for the 6 centimeter system, failed during the first few days on the telescope. It has been returned to the manufacturer for repair and modification.

A new intermediate frequency system for the autocorrelation receiver has been completed and is now being tested.

The following projects have been initiated:

1. A 10 centimeter system for the 140-foot telescope.
2. A 20 centimeter system for Zeeman effect experiments with the 140-foot telescope.
3. Systems to be used at 18 and 21 centimeters with the autocorrelation receiver.
4. Two low frequency systems (234 and 405 MHz) for the 300-foot telescope.

Work is continuing on the new solid-state intermediate frequency and synchronous detector system.

The electronic systems for the 3-element interferometer are being assembled. The on-line computer has been selected and is presently being integrated into the overall system.

The following electronics division internal reports were issued during the period:

No.	Title	Author
51	Interferometer Receiver Back End	J. Coe
52	Square Law Detector for the 6 cm Tunnel Diode Amplifier	J. Dolan
53	NRAO Interferometer Phase Lock Loop Operating-Service Report	J. Bringe

THE NRAO MILLIMETER WAVE ANTENNA

On-Site Work at Kitt Peak

During severe winter weather, high winds (up to 60 mph) tore the partly completed plastic dome covering sections apart. Replacement of the covering material, together with a review of the quality control and material specifications, was found necessary. The delivery time of the new covering material may delay the telescope completion date until the beginning of June.

Telescope Fabrication, Rohr Corporation

The machining of the telescope surface has been completed. Measurements of 1728 points on the reflecting surface resulted in a measured surface accuracy of 0.1 mm (0.004") rms.

After completion of the work in the Rohr plant, the reflector was transported to the foot of the Kitt Peak mountain where it was parked pending the completion of the dome cover.

Power

A tentative agreement was reached between AURA and the local power company (TRICO) for the construction of a power transmission line to supply the 36-foot telescope with electric power. This power supply is expected to be in operation about July 1. Adequate temporary power is available on the site for construction work and initial testing and operation of the facility.

ANTENNA DESIGN STUDIES

The Largest Feasible Steerable Telescope

The LFST group issued a report, which was distributed to scientific members, in late January covering the progress made to date. It describes the various possibilities that have been investigated and could be used ultimately in a final design of a Very Large Steerable Telescope.

A complete report was submitted by Lear Siegler, Inc., on February 7, 1966, on their analysis of a concrete spherical shell design. Findings by Lear Siegler concur closely with those of a study made by O. Heine, a member of the LFST group.

North American Aviation has been awarded a study contract for a 600-foot diameter floating sphere, in which they propose to use steel-faced honeycomb panels, hang the secondary reflector via cables, and float the sphere on an air cushion. Their first progress report is now being evaluated. NAA has tentatively scheduled May 18, 1966, for a report and review of their study to the LFST study group.

Other LFST study group members are currently undertaking various studies. Interesting advances are in the making, specifically in reference to S. von Hoerner's homology structural analysis, as well as the conceptual design of a fixed-elevation transit telescope with a large surface flat on the ground.

As a final note, the LFST group regrets to announce the departure of M. M. Small from its active roster, and wishes him the best of luck in his new position at the Brookhaven National Laboratory.

The Very Large Antenna Array Project

Studies of the array configuration were continued, mainly by D. Hogg and Y. Chow, using the transfer-function analysis program for the IBM 7040 computer. Efforts were concentrated on the symmetrical Y-array, with hour-angle track and element-position as parameters. It is found that the "field-of-view" (spacing of grating lobes) can be increased greatly by using long hour-angle tracks, with the result that a grating-lobe-free beam can probably be synthesized by about 40 antennas in 8 hours, to an angular resolution of 10". Chow continued his investigation of the minor lobe responses due to missing cells in the transfer function.

Under S. Weinreb's direction, invitations were sent to various firms to submit proposals for preliminary design and cost studies for the principal electronic systems of the VLA. Several attractive proposals were received, and ITT Laboratories, Inc., has been selected to perform this study.

A similar effort is being made with respect to the antennas under H. Hvatum's direction.

Collins and Rice, Inc., civil engineers of Springfield, Illinois, have prepared cost estimates and preliminary designs for the railway and (alternative) roadway systems for the array arms for a hypothetical site. Roadways are lower in initial cost, but probably require more costly and less satisfactory rolling stock, as well as greater maintenance. Railways could be provided for a 10" arc array for $1.7 million, for the hypothetical site. This includes drainage, grading, ballast, track, and observing stations.

C. Wade, M. Small, and G. Swenson (University of Illinois) have made field investigations of several sites, selected after a thorough map-search of all possible sites in the USA below 35° N latitude. Three have been chosen for detailed investigation and comparison, including preliminary design and costing of the necessary engineering and architectural work for the development of each site. After preliminary work has progressed to a sufficient degree, one site will be eliminated and the plans completed in greater detail for the remaining two. This study is intended to give typical cost and design data, rather than to result in a final site selection; however, the sites selected are the three most attractive discovered so far. An engineering firm to conduct this study is presently being selected.

A preliminary organization for the VLA project has been conceived, and a project office established. The organization will have two parallel branches:

the design group and the project staff. The former is to be in the form of a committee of certain members of the NRAO scientific staff, plus several participating members from universities, and is to be responsible for the conceptual design of the instrument. The project staff will be a line organization, responsible for detailed design, supervision of subcontractors, and staff support of the design group. One individual will serve as chairman of the design group and as leader of the project staff. NRAO members of the design group will, on the average, spend one-half time on VLA matters. Members of the project staff will be exclusively concerned with the VLA project.

G. W. Swenson, Jr., has been designated chairman of the design group and will serve full time in this capacity while on extended leave-of-absence from the University of Illinois.

PERSONNEL

Mr. Karl Wesseling, electronics engineer from The Hague, Netherlands, began employment in our Green Bank electronics laboratory on March 7.

Mr. Dwayne H. Moore joined the Charlottesville computer division on March 23 as a programmer. Mr. Moore was previously employed by the Telecomputing Services Inc., at Edwards Air Force Base, California.

After a warm four year association with the Observatory during which he, as project manager, saw the 140-foot telescope to a successful completion, Maxwell M. Small transferred to the Brookhaven National Laboratory on March 20. During the last half-year at the NRAO, Mr. Small became actively involved in the Observatory's search for sites for the Very Large Array and participated in the LFST design studies.

Mr. John R. Plunkett, administrative services officer, resigned on January 31, to accept a position in Cherry Hill, New Jersey.

MISCELLANEOUS

Final financial arrangements for the Charlottesville facility have been officially completed with the University and are now in effect. The building was officially occupied on December 20, 1965.

Bid packages for the interferometer control building were mailed on March 25, requesting bids returnable by April 25. It calls for immediate start of construction upon awarding of the contract and completion on a 100 day program.