US/GR BK/

National Radio Astronomy Observatory
Charlottesville, Virginia

Quarterly Report

January 1 - March 31, 1970

RESEARCH PROGRAMS

Interferometer (three 85-foot telescopes and the 42-foot telescope)

		Hours
Scheduled observing		2024.25
Scheduled maintenance and equipment changes		119.75
Time lost due to:	equipment failure	35.75
	power	10.75
	weather	63.25
	interference	5.50

Observations during this quarter, all at 11-cm wavelength, were as follows:

Observer	Program
M. Kaftan-Kassim (Albany) and S. Zisk (Lincoln Lab)	11-cm brightness maps of planetary nebulae.
M. Davis	Positions and structure of the survey sources studied at 1400 MHz with the 300-foot telescope.
G. Miley and C. Wade	Positions and structure of radio sources not optically identified on Palomar-Schmidt plates.
R. Rubin (Illinois) and D. Hogg	Measurements of the positions, flux densities and angular sizes of the planetary nebulae MI 78 and A 77.
B. Clark and D. Hogg	Fan beam synthesis of radio sources.
B. Hermann (Illinois) and J. Dickel (Illinois)	Aperture synthesis and polarization measurements of supernova remnants.
D. Cudaback (Berkeley), C. Heiles (Arecibo), and B. Turner	Synthesis of H II regions.
C. Wade and R. Hjellming	Observations to attempt to detect stars of spectral types B and M.

Observer	Program
W. Altenhoff (Max-Planck-Institut für Radioastronomie, Bonn, Germany) P. Mezger, W. Webster, R. Hjellming, and J. Wink	Aperture synthesis measurements of fine structure in H II regions.
G. Miley	Extended baseline observations of small-scale source structure using the 42-foot telescope at the Spencer's Ridge site (100,000 wavelengths to 85-1) and 85-1 and 85-2.

A preliminary test of the new 2695-MHz and 8085-MHz dual-frequency system was conducted by D. Hogg, S. Weinreb, and J. Coe.

300-foot Telescope

		Hours
Scheduled observing		1920.00
Scheduled maintenance and equipment changes		135.25
Time lost due to:	equipment failure	20.25
	power	0.00
	weather	0.00
	interference	7.25

The following line observations were conducted during this quarter:

Observer	Program
S. Gottesman	21-cm line observations of galaxies to determine the congruence of optically defined spiral arms with neutral hydrogen emission and high resolution mapping of neutral hydrogen in absorption in the Cygnus X complex.
M. Roberts	21-cm line search for neutral hydrogen absorption in the direction of BL Lac (VRO 42 22 01).

The following continuum observations were conducted during this quarter:

Observer	Program
J. Pfleiderer (ESRO Fellow)	1400-MHz observations to detect radio emitting elliptical galaxies.
K. Kellermann and I. Pauliny-Toth	1400-MHz observations of flux densities of variable sources.

Observer	Program
G. Swenson (Illinois), J. Webber (Illinois), J. Dickel (Illinois), and B. Hermann (Illinois)	Observations at 1400 MHz to confirm and measure the spectra of the Vermillion River Observatory Source List and to measure the flux densities of several planetary nebulae.
J. Maslowski (Jagellonian University, Poland)	1400-MHz survey of the sky from declination +48° to +51° to collect data for the support of cosmological investigations and evolutionary investigations of radio sources.
A. Bridle (Queen's University) and M. Davis	1400-MHz catalog of sources down to 2.0 flux units over a large area of the sky.

The following pulsar observations using the tracking feed assembly were conducted during this quarter:

Observer	Program
D. Staelin (M.I.T.), B. Burke (M.I.T.), M. Ewing (M.I.T.), M. Price (M.I.T.), R. Batchelor (M.I.T.), and J. Sutton	Observations over the frequency range of 100-200 and 400 MHz of known pulsars to determine their frequency and time structure, polarization properties, and a search for new sources exhibiting pulsar-like characteristics.
R. Manchester	410-MHz observations to determine improved pulsar positions and periods, and to determine the variation of the four Stokes parameters for pulsar radiation as a function of pulse phase.

121.6 MHz very long baseline observations of pulsars and quasars using the NRL Maryland Point 84-foot telescope, the NRL Sugar Grove 150-foot telescope, and the 300-foot telescope were conducted by W. Erickson (Maryland) and S. Knowles (NRL).

140-foot Telescope

		Hours
Scheduled observing		1975.00
Scheduled maintenance and equipment changes		169.00
Time lost due to:	equipment failure	47.50
	power	0.75
	weather	20.75
	interference	2.25

Line observations were conducted as follows:

Observer	Program
P. Solomon (Columbia) and P. Thaddeus (Columbia)	Studies of the cosmic background and interstellar radiation at the 14.488-GHz line of H_2CO and a search for new molecules.
W. Howard and H. Hvatum	Search for strong spectral lines over the range of 12.4 to 15.1 GHz and 15.3 to 17.3 GHz in the radio sources Sgr A, Sgr B2, W49, Cas A, W3, Ori A, and VY Canis Majoris.
L. Snyder (Virginia), P. Palmer (Chicago), B. Zuckerman (Maryland), and D. Buhl	Search for new molecules in the range 12 to 18 GHz.
P. Palmer (Chicago), B. Turner, and B. Zuckerman (Maryland)	13.4-GHz search for excited OH lines in galactic sources.
C. Heiles (Arecibo), E. Scharlemann (Cornell), B. Turner and W. Brundage	Search for new molecules at 111, 411, and 431 MHz in the direction of the galactic center.
L. Snyder (Virginia), D. Meisel (Virginia), D. Buhl, and B. Turner	Search for new molecules in the comet Tago-Sato-Kosaka in the frequency range 111-455 MHz.
E. Churchwell (Indiana) and B. Turner	Search for low-frequency recombination lines of hydrogen and carbon that would be expected to occur in the frequency range 390-450 MHz in Orion A.
C. Heiles (Arecibo), and G. Miley	482-MHz search for red shifted 21-cm neutral hydrogen absorption lines in quasars with large emission red shifts.
L. Snyder (Virginia), C. Gottlieb (Harvard), J. Pasachoff (Harvard), D. Dickinson (Smithsonian), P. Palmer (Chicago), B. Zuckerman (Maryland), and D. Buhl	Search for deuterated hydroxyl radical (OD) at 310 MHz and ketene at 375 MHz in the direction of the galactic center.
D. Meisel (Virginia) and B. Turner	Observations of 18-cm OH lines in the comet Tago-Sato-Kosaka.

Observer	Program
M. Gordon and R. Manchester	Observations of 18-cm OH lines in Orion B and adjacent areas, in W14, W22, and W37 and a search for OH in the direction of pulsars 0329+54, 1133+16, 1642-03, 1749-28, and 1929+10.
A. Barrett (M.I.T.) and W. Wilson (M.I.T.)	18-cm OH observations of the infrared star IRC +10011.
J. Knapp (Maryland)	High resolution 18-cm OH and 21-cm H I observations in the Taurus Nebula and in cloud L 1709.
F. Kerr (Maryland), W. Sullivan (Maryland), and S. Knowles (NRL)	18-cm OH line observations of galactic sources to study the variation of intensity and frequency with time.
J. Ball (Harvard), A. Lilley (Harvard), A. Dupree (Harvard), L. Goldberg (Harvard), D. Cesarsky (Harvard)	18-cm line observations to test the Goldberg-Dupree theory regarding structure in recombination line profiles and a few observations to examine Hβ intensities.
B. Zuckerman (Maryland) and J. Ball (Harvard)	18-cm observations of $O^{18}H$ and $O^{17}H$ in absorption in the galactic center and the search for $O^{16}H$ in M31 and M82.
A. Sandqvist (Maryland)	High-frequency resolution measurements of the 21-cm line of neutral hydrogen in absorption in Cas A, Cyg A, M17, and Tau A.
M. Roberts	21-cm neutral hydrogen observations to confirm previous measurements of the dimensions of M81, to search for neutral hydrogen in other galaxies and to map Sgr A in the recombination lines of H166α, H167α, and H168α.
S. Goldstein (Virginia)	21-cm neutral hydrogen observations to measure the opacities and velocity fields of high latitude hydrogen clouds.
J. Basart (Iowa State) and D. Trizna (NRL)	21-cm neutral hydrogen observations to measure the delay in the propagation of pulsar emission through interstellar hydrogen.

Observer	Program
H. Helfer (Rochester) and J. Perry (Rochester)	21-cm observations to establish a statistical model of neutral hydrogen in the Perseus spiral arm.
P. Lindblad (Stockholm, Sweden)	21-cm observations of neutral hydrogen in the distant outer arm of the galaxy.
E. Churchwell (Indiana), J. Maslowski (Jagellonian University, Poland), and P. Mezger	Observations at 5009 MHz to measure helium abundances, particularly in those sources that have been previously observed to have low helium abundances and observations at 5038 MHz to search for the $He^{+}173\alpha$ line in those sources where no helium has been previously detected by observing at the frequency of the He109α lines.
L. Biermann (Max-Planck Institut, Munich, Germany), W. Huebner (Max-Planck Institut, Munich, Germany), and L. Snyder (Virginia)	5-GHz search for formaldehyde in Comet Bennett.
A. Barrett (M.I.T.), P. Schwartz (M.I.T.), and W. Wilson (M.I.T.)	5-GHz search for formaldehyde associated with infrared stars.
A. Barrett (M.I.T.), D. Thacker (M.I.T.), and W. Wilson (M.I.T.)	OH-line search for the $^{2}\pi_{1/2}$, J = 1/2 excited state in ten OH infrared stars at 4660 MHz and to search in ten other such sources at all three excited state frequencies within the range 4750-4766 MHz.
P. Palmer (Chicago) and B. Zuckerman (Maryland)	Search for the 4660-MHz OH line.
F. Kerr (Maryland) and P. Jackson (Maryland)	5-GHz observations to attempt to detect H109α radiation from distributed ionized hydrogen in the spiral arms of the galaxy.
F. Kerr (Maryland) and A. Sandqvist (Maryland)	Lunar occultation of the galactic center at the 4830-MHz formaldehyde line.
M. Gordon	5-GHz recombination line observations of the 109α and 137β lines of hydrogen and helium and 156γ line of hydrogen in W3 and W49.

Observer	Program
M. Roberts	5-GHz observations to attempt to detect recombination lines and other spectral lines in galaxies.

The following continuum observations were conducted during this quarter:

Observer	Program
I. Pauliny-Toth and K. Kellermann	4.995 and 15.375-GHz flux density measurements of variable sources.
L. Matveyenko (Cosmic Space Institute, Moscow)	4.995 and 15.375-GHz observations to map the Crab Nebula.
M. Simon (Stony Brook) and D. Buhl	15.375-GHz observations of the March 7 solar eclipse to derive the temperature distribution of several active solar regions and a search for solar limb brightening.
S. Goldstein (Virginia) and F. Gauss (Virginia)	Tests to evaluate the instrumental polarization effects of a 1400-MHz system on the 140-foot telescope over a bandwidth of ±100 MHz.

The following VLB observation was conducted during this quarter:

Observer	Program
D. Jauncey (Cornell), W. Erickson (Maryland), and M. Cohen (Calif. Inst. Tech.)	Very long baseline observations at 111, 318, and 610 MHz using the Arecibo 1000-foot antenna, an Owens Valley 130-foot antenna, and the 140-foot NRAO antenna.

36-foot Telescope

		Hours
Scheduled observing		1639.50
Scheduled maintenance and equipment changes		47.50
Time lost due to:	equipment failure	142.50
	power failure	8.00
	weather	219.50
	interference	7.00

Observer	Program
K. Kellermann and I. Pauliny-Toth	Continuation of a program to measure flux densities of variable sources and spectra of opaque sources, extended galaxies, and QSO's at 31 and 85 GHz.

Observer	Program
E. Conklin	Search for radio emission from all known BSO's at 31 and 85 GHz.
P. Boynton (Princeton) and R. Partridge (Princeton)	Measurement of the fine-scale anisotropy of the cosmic microwave background radiation at 85 GHz.
W. Dent (Massachusetts) and R. Hobbs (NASA)	Instantaneous spectra of extragalactic variable radio sources at 31 and 85 GHz with the 36-foot; simultaneous observations at other frequencies with the Haystack 120-foot antenna.
E. Conklin	Observations of sources from the Ohio State catalog having unusually flat spectra, to see if they are optically thin, at 31 and 85 GHz.
M. Kundu (Maryland)	Solar mapping at 31, 85 and 300 GHz; monitoring of active regions to study the evolution of noise bursts and solar flares.
M. Simon (Stony Brook)	Study of 300-second oscillations in the solar chromosphere at 31 and 85 GHz; search for limb brightening at 85 GHz during the solar eclipse.
R. Hobbs (NASA)	Attempt to measure the flux density of infrared objects at 85 GHz.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

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

Interferometer Development	14%
Interference Protection	2%
Millimeter Receiver Development	10%
Very Long Baseline Interferometer	6%
24-GHz Receiver	3%
Pulsar Receiver Construction	6%
3-cm Receiver	4%
6-cm Receiver	5%
413-Channel Correlator	9%
50-Channel Receivers	4%
Visitor Support and Routine Maintenance	29%
21-cm Cooled Paramp	3%
Antenna Measuring Instrument	2%
12-18 GHz Receiver	3%

A 115-GHz receiver, jointly built by NRAO and Bell Telephone Laboratories, has been completed and installed at the 36-foot telescope. The receiver utilizes a phase-locked local-oscillator system, a parametric I.F. amplifier, and a Schottky-diode mixer.

The 3 cm/11 cm interferometer front-ends are complete and will be installed in April. New interferometer delay-line systems have been delivered by Andersen Laboratories and will also be installed. The new delay lines allow dual-channel operation of the interferometer at three times the existing bandwidth.

Parametric amplifiers covering the 5-10 GHz range have been received and construction of a front-end to incorporate these units has begun. Delivery of the new VLB recording system is expected in April.

A project to test an optical position reference system for the homology telescope has been initiated. The reference system requires stabilization of a movable platform to an accuracy of one second of arc.

ENGINEERING DIVISION

In the first quarter of 1970 major areas of effort of the Engineering Division have been:

1. The contract for fabrication, erection, and alignment of the new surface panels for the 300-foot telescope was awarded to Radiation Systems, Inc. of McLean, Virginia. Work is proceeding on geometry analysis, tool design, and fabrication, panel dimensional and detail drawings, and erection control analysis. Material is on order with delivery expected shortly to the fabricator; detailed part fabrication has been started, with panel assembly expected to start shortly. The contract price is $543,000.

2. An evaluation of the present surface accuracy of the 85-foot diameter antennas has been made and preparations are complete to adjust the surface during the second quarter of 1970. This adjustment is necessary to improve efficiency after the new 3.75-cm observing system is installed.

3. The design of a tracking feed for the 300-foot telescope is complete and a report has been issued which describes the design, control and performance of the proposed tracking mount. This design has been a joint effort of the Electronics and Engineering Divisions.

4. Detail drawings and estimate of cost for an indoor-outdoor test facility are now available.

COMPUTER DIVISION

Hardware

An additional 9-track tape drive has been installed. There are now four 9-track drives and two 7-track drives on-line with the IBM 360/50 system.

A 50 percent increase in core storage has been installed. A total of 270K bytes of core storage is now available to the user. This amount is normally divided into three 90K byte partitions or one 90 and one 180K byte partition.

Rental of the paper tape reader previously located in Green Bank has been terminated.

Software - system

IBM operating system release 18 has been installed during this quarter. Work has been started on implementing a system software package, HASP. HASP is an IBM supplied package designed to improve overall system thruput by acting as an interface between the operating system and low speed I.O. devices (i.e., printer, punch, etc.).

Software - user

A series of programs to allow use of the autocorrelation receiver in the total power mode was completed.

A program for the on-line computers at the 140-foot and 300-foot telescopes was developed which records data from the Fabri-Tek signal-averager and provides various on-line displays.

Work was continued on making on-line software at the 140-foot more compatible with that at the 300-foot telescope.

Work was begun on a system of programs for the new autocorrelation receiver.

ANTENNA DESIGN STUDIES

The Homology Telescope

Design work continues on a 65-meter diameter azimuth-elevation fully-steerable parabolic antenna. The principles of the design are to make full use of homology to reduce to a minimum the effects of gravity deformations of the structure. The general telescope structure is derived from the 300-foot design; the first phase of which was completed last summer. The design is for a telescope which can be used with Cassegrain or prime-focus optics, and the present design goal is to achieve satisfactory performance at 3.5 mm wavelength (86 GHz).

PERSONNEL

Appointments

Dewey E. Ross	Electronic Engineer	January 5, 1970
Richard L. Fleming	Electronic Engineer	January 26, 1970
*Virginia Van Brunt	Librarian	March 2, 1970
W. Bruce McAdam	Visiting Scientist	March 3, 1970
Craig W. Moore	Electronic Engineer	March 23, 1970

*Part-time until May 1, 1970

Terminations

Peter Stumpff	Head - Computer Division	February 13, 1970
L. D. Gore	Electronic Engineer	March 13, 1970

Leave of Absence

Gerrit L. Verschuur	Assistant Scientist	January 1, 1970-June 30, 1970
Peter G. Mezger	Scientist	January 19, 1970-February 16, 1970