US/GR BK/

National Radio Astronomy Observatory
Charlottesville, Virginia

Quarterly Report

January 1 - March 31, 1969

RESEARCH PROGRAMS

Interferometer (three 85-foot telescopes)

		Hours
Scheduled observing		2055.00
Scheduled maintenance and equipment changes		105.00
Time lost due to:	equipment failure	61.50
	power	0.00
	weather	65.00
	interference	7.75

During this quarter the following programs were continued at 11 cm wavelength:

Observer	Program
J. Basart, B. Clark, and G. Miley	Observations with a phase-stable interferometer of 200,000 wavelengths baseline, using the 42-foot portable telescope.
G. Miley and G. Macdonald	A study of the structure of 70 quasi-stellar radio sources.
B. Clark and D. Hogg	Fan beam synthesis.
E. Fomalont (Calif. Inst. of Tech.)	Synthesis of the polarization brightness distribution of about 50 sources from the 3C catalog.
J. Basart, D. Buhl, and A. Sinclair (Bell Comm. Inc.)	Interferometric observations of Venus around inferior conjunction and the synthesis of Jupiter.
J. Basart	VLA-study data to attempt to correlate water vapor fluctuations measured by hygrometers following the sun and phase fluctuations observed in the output of the interferometer as it observed a radio source near the sun.

140-foot Telescope

		Hours
Scheduled observing		1987.00
Scheduled maintenance and equipment changes		168.50
Time lost due to:	equipment failure	183.50
	power	0.00
	weather	67.25
	interference	0.00

There were three very-long baseline (VLB) observations during this quarter, as follows:

Observer	Program
B. Burke (M.I.T.), H. Hinteregger (M.I.T.), I. Shapiro (M.I.T.), and C. Knight (M.I.T.)	OH line observations with the 140-foot and Haystack 120-foot telescopes to support a previous attempt to accurately measure the positions of two radio sources 3C 273 and 3C 279 near the sun, looking for the combined effect of the relativistic bending of radio waves by the sun's gravitational field and refraction effects in the sun's corona. Studies to develop VLB observing techniques to establish very accurate geodetic measurements.
O. Rydbeck (Chalmers Inst. of Tech., Sweden), B. Hansson (Chalmers Inst. of Tech., Sweden), M. Cohen (Calif. Inst. of Tech.), D. Jauncey (Cornell), K. Kellermann, and B. Clark	6 cm continuum observations using the California Institute of Technology's 130-foot telescope, the Chalmers Institute of Technology's 84-foot telescope, and the 140-foot telescope.
M. Cohen (Calif. Inst. of Tech.), D. Jauncey (Cornell), B. Clark, and K. Kellermann	6 cm observations using the 130-foot telescope of the California Institute of Technology, the Parkes (Australia) 210-foot telescope, and the 140-foot telescope.

The following additional line observations were conducted during the quarter:

Observer	Program
K. Gordon (Michigan), C. Gordon, and A. Shalloway	Observed 21 cm line absorption in the vicinity of known pulsars, using 234, 256, and 405 MHz equipment to assist in identifying the pulsars and in studying amplitude and pulse shapes.

Observer	Program
G. Verschuur	Extension of program of observations of sources to determine magnetic field using Zeeman splitting of 21 cm line of neutral hydrogen.
M. Roberts	H I measurements of the systemic radial velocities of galaxies whose radial velocities exceed 900 km/sec.
R. Rubin and B. Turner	An attempt to detect H109α radiation in NGC 6857 and K 3-50 to determine the temperature of this object.
F. Kerr (Maryland) and A. Sandqvist (Maryland)	Lunar occultation of the galactic center at H and OH-line frequencies.
F. Kerr (Maryland) and R. Harten (Maryland)	Study of galactic neutral hydrogen in the cardinal directions (ℓ^{II} = 0°, 90°, 180°, 270°) to check the Lin theory of galactic gas distribution at southern declinations outside the range of the 300-foot telescope.
H. Helfer (Rochester) and J. Perry (Rochester)	Neutral H-line observations to develop a model of the Perseus spiral arm with particular emphasis on the density distribution of the hydrogen perpendicular to the galactic plane and measurements of the frequency distributions of cloud complexes of various masses within the spiral arm.
P. Mezger, W. Altenhoff, and E. Churchwell (Indiana)	Measurement of H109α lines and some of the higher order recombination lines in extended H II regions in order to determine the galactic abundance of helium. Measurements of non-thermal galactic sources to obtain their continuum spectra and line emission.
D. Buhl, L. Snyder, P. Palmer (Chicago), and B. Zuckerman (Maryland)	Detection of interstellar formaldehyde (H_2CO) at 6 cm wavelength.
E. Lilley (Harvard), H. Penfield (Harvard), P. Palmer (Chicago), B. Zuckerman (Maryland)	Observations of the C109α line in the direction of 18 cm OH sources and a measure of the $^2\pi_{1/2}$, J = 1/2 lines of OH in W3 and other sources.

Observer	Program
A. Barrett (M.I.T.) and T. Wilson (M.I.T.)	Observations of NML Cygni for $^2\pi_{1/2}$, J = 1/2 OH transitions.
Y. Terzian (Cornell) and B. Balick (Cornell)	Measurements of the H109α recombination line in planetary nebulae.

The following continuum observations were conducted:

Observer	Program
M. Davis, I. Pauliny-Toth, and K. Kellermann	6 cm survey of selected regions, including 5C1 and 5C2 sources.
C. Wade	6 cm observations of spiral and irregular galaxies to support observations taken with the interferometer.
D. Heeschen	6 cm observations of E and SO galaxies.
M. Kundu (Maryland)	Measurements of the polarized brightness distributions of supernova remnants at 6 cm.
T. Wilson (CSIRO)	6 cm observations of galactic radio sources to supplement data collected at the 210-foot Parkes (Australia) telescope.
D. Morrison (Cornell)	Measurements of the phase effects of Venus at 6 cm.
D. Morrison (Cornell), C. Sagan (Cornell), and M. Klein (JPL)	Brightness temperature measurements of Mercury at 6 cm to obtain phase effects and the mean brightness temperature.

300-foot Telescope

		Hours
Scheduled observing		1997.50
Scheduled maintenance and equipment changes		161.00
Time lost due to:	equipment failure	11.75
	power	0.00
	weather	5.50
	interference	10.75

During this quarter two programs using very-long baseline techniques were conducted simultaneously with the California Institute of Technology's 130-foot telescope at Owens Valley and the 300-foot telescope observing at

111 MHz. The first set of observations were undertaken by W. Erickson (Maryland) and F. Ahern (Maryland) and were made at the position of the pulsar NP 0527 in the Crab Nebula and quasars 3C 138 and 3C 147 used as calibrators. The second set of observations were conducted by G. Miley and M. Cohen (California Institute of Technology) and consisted of low-frequency measurements of selected quasars.

Other observations were as follows:

Observer	Program
G. R. Huguenin (Massachusetts) and J. Taylor (Harvard)	The measurement of the dynamic spectra and polarization of known pulsars and a search for new pulsars at 111 MHz and 405 MHz.
D. Staelin (M.I.T.) and E. Reifenstein	Observations of known pulsars to determine internal pulse structure and variability; search for new sources exhibiting pulsar-like characteristics at 111, 234, and 405 MHz.
G. Swenson (Illinois), J. Dickel (Illinois), and H. Dickel (Illinois)	Observations at 1400 MHz to verify the Vermillion River Observatory source list.
E. Churchwell (Indiana) and M. Felli (Arcetri, Italy)	Survey of Sharpless H II Regions at 1400 MHz.
K. Kellermann and I. Pauliny-Toth	1400 MHz measurements of the flux densities of variable sources.
D. Jauncey (Cornell) and A. Neill (Cornell)	1400 MHz measurements of fluxes of 4C sources and other uncatalogued sources whose fluxes have been found to be less than 0.7 flux units at 408 MHz to supplement data collected at Arecibo and Australia.

36-foot Telescope

		Hours
Scheduled tests and observing		920.0
Scheduled maintenance and equipment changes		0.0
Time lost due to:	equipment failure	166.0
	power	0.0
	weather	453.0
	interference	0.0

During this quarter 300.5 hours were spent observing (246.5 hours for pointing, testing and telescope calibration and 54 hours for research programs). The following research programs were carried out:

Observer	Frequency (GHz)	Program
J. Schraml	31.4	Map of Orion Nebula and W33.
K. Kellermann	31.4	Flux densities of extragalactic sources.
D. Heeschen	85	Flux densities of elliptical galaxies.
J. Schraml	85	Map of Orion Nebula.
F. Low (Arizona) and K. Kellermann	300	Flux densities of extragalactic sources.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

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

Interferometer Development	10%
Interference Protection	9%
Millimeter Receiver Development	8%
Very Long Baseline Interferometer	12%
OH-Line Receiver Construction	12%
Water Vapor Receiver	10%
Pulsar Receiver Construction	4%
Visitor Support and Routine Maintenance	35%

Development work on the VLA electronics system was terminated in January 1969. This work is described in VLA Proposal, Volume 3.

An equipment upgrading program for the 3-element interferometer has begun. This will include dual-frequency (2695/8085 MHz) front-ends, increase of I.F. bandwidth to 35 MHz, and incorporation of a dual-channel delay and correlation system. Completion is expected by March 1970.

The development of new very-long baseline (VLB) recording terminals and a data processor has been planned for completion in April 1970. A computer has been selected and proposals for the recording system have been received. Portable front-ends for VLB use at wavelengths of 6 cm and 3 cm have been completed.

The interference van receivers, the 6 cm receiver rebuilding, and an 18-26 GHz receiver have been completed. A new 6-cm receiver and a 22-24 GHz paramp are under construction.

The completion of the new OH-line receiver has been delayed somewhat due to illness of an engineer. Completion of the system by July 1969 is expected.

Initial plans for a new 400 to 1000 channel auto/cross-correlation receiver are being made.

ANTENNA DESIGN STUDIES

The Homology Telescope

The conceptual design of a 91.5 m (300-foot) fully steerable homologous telescope has progressed to a stage where it can be concluded that the telescope is both feasible and practical. The present cost estimate is 8 million dollars.

Item	Cost
Basic telescope and drive system	$ 6,410,000
Buildings, power, water, site preparation	400,000
Detailed engineering, etc.	500,000
Total telescope	$ 7,310,000
Contingency ≈ 10%	690,000
Total estimate	$ 8,000,000

Calculations show that the rms surface accuracy will be 1.0 mm under sunny and calm conditions and 0.76 mm when the sun is not shining and the wind is below 18 mph. The shortest operating wavelengths will then be 1.6 cm and 1.2 cm (16 x rms), respectively, with the aperture efficiency having been reduced to about 30% by the surface irregularities.

NOISE AT GREEN BANK

Observations of pulsars have emphasized the radio noise problem at Green Bank. Observations in the frequency range 100-400 MHz have often encountered serious difficulties due to locally generated radio noise.

Several sources of this noise can be identified:

(a) Ignition noise from gasoline-driven motor vehicles;
(b) Power line noise from overhead lines;
(c) Switching transient noise from mechanical switches or generated within digital switching circuits;
(d) Faulty TV signal boosters; and
(e) Other.

The problems of site noise reduction are in the hands of the Electronics Division, with J. Dolan and M. Waslo doing the work.

A well-equipped interference detecting and measuring vehicle has been built and is now in use. A full description of this vehicle is being prepared and will soon be issued as an internal report.

The ignition noise problem has been studied and worked on now for many years. There is no practical means by which a spark-ignition vehicle can be

so treated that it will never cause troublesome interference to radio astronomy if it is driven close to radio telescopes.

The noise sources of a diesel engine, however, are reduced to such items as generator or alternator sparking, voltage control devices, on-off switches, etc., and these can be adequately suppressed. Thus for Green Bank we have recently emphasized the policy of "diesels only" on the observing site. Our own vehicles are already partly diesel, and the change-over of truck and pick-up chassis to diesel engines is continually being done by the automotive shop at Green Bank. The National Science Foundation has authorized the purchase of diesel passenger cars for on-site movement of observers, etc. Four have now been delivered and are in extensive use. A control gate has been placed on the high school road access to the site.

Thus we can now run the Observatory with only diesel vehicles operating within the two control gates at the Works Area and near the high school. This we shall now do whenever observing programs make it desirable. Later, when we reach the stage of full diesel-engined vehicles, we will continuously run the site in this manner.

The overhead power-line problem should have been reduced to very small proportions by now. Since we began at Green Bank we have gradually removed overhead power lines. Nevertheless, the local villages still are served by overhead lines and these give trouble. The faults are due to arcs and sparks at hardware, insulators, ground wires, etc. The final solution is that all the local power lines should go underground. The cost of this will be high, but negotiations with the power company have been started. This very troublesome and time-consuming operation consists of improving insulators, rectifying poor hardware connections, and similar types of activity.

We know of quite a lot of switching-noise problems, such as noise spikes from thermostats, and we have had cases of TV signal boosters that radiate spurious signals in the VHF band, and steps are being taken to minimize these and other problems of local radio noise generation.

We ask all observers to note and report their noise problems to J. Dolan or M. Waslo. We will do our best to identify and clean-up the source of interference.

PERSONNEL

Appointments

John M. Sutton	Research Associate	March 3, 1969

Terminations

Edward B. Fomalont	Visiting Assistant Scientist	February 14, 1969

K. I. Kellermann left on March 1, 1969 for a three months' leave of absence at the California Institute of Technology.