

National Radio Astronomy Observatory  
Charlottesville, Virginia

Quarterly Report

July 1 - September 30, 1969

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RESEARCH PROGRAMS

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

	<u>Hours</u>
Scheduled observing	1999.50
Scheduled maintenance and equipment changes	192.50
Time lost due to: equipment failure	62.75
power	2.00
weather	7.75
interference	8.50

The 42-foot telescope at Huntersville was remotely operated via radio link from Green Bank during this quarter.

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

<u>Observer</u>	<u>Program</u>
B. Clark and D. Hogg	Fan beam synthesis of radio sources.
D. Buhl, J. Basart (Iowa State), and A. Sinclair (Bellcomm)	Interferometric observations of planets.
D. Heeschen	Observations of E and SO galaxies to determine more precise positions and to investigate their size and structure.
G. Miley, J. Basart (Iowa State), and B. Clark	Interferometric observations over a 35 km baseline to evaluate and support the proposed VLA concept, using the 85-1 and 42-foot telescopes.
D. Cudaback (Berkeley), C. Heiles (Berkeley), and B. Turner	Synthesis of H II regions -- a continuing program.
G. Miley and G. Macdonald	Study of the structure of approximately 70 quasistellar radio sources.
J. Sutton	Interferometric studies of lunar-occulted sources studied at the NRAO and Arecibo.

G. Miley, W. Webster (Case Western Reserve), and W. Altenhoff (Max Planck Institut für Radioastronomie, Germany)

A study of fine structure of H II regions and planetary nebulae, using the 85-1 and 42-foot telescopes to study at the 35 km baseline sources not yet resolved at 2700 m spacing.

### 300-foot Telescope

	<u>Hours</u>
Scheduled observing	1855.0
Scheduled maintenance and equipment changes	353.0
Time lost due to: equipment failure	31.0
power	0.0
weather	26.0
interference	0.0

A traveling feed carriage designed for low frequency use (up to about 400 MHz) was installed on the telescope during this quarter and will permit a source to be tracked in excess of one hour.

During this quarter, the 300-foot telescope was painted. This is the principal reason for the reduction in the number of hours for scheduled observing.

Line observations were conducted as follows:

<u>Observer</u>	<u>Program</u>
K. Gordon	Search for neutral hydrogen in approximately 100 high-velocity galaxies to gain a significant improvement in the statistical sample of galaxies that exhibit useful 21-cm data.
L. Snyder (Virginia), D. Buhl, P. Palmer (Chicago), B. Zuckerman (Maryland), C. Gottlieb (Smithsonian Astrophys. Observatory), D. Dickinson (Smithsonian Astrophys. Observatory), J. Pasachoff (Harvard), and J. Ball (Harvard)	Search for new molecules at approximately 375 MHz in all known formaldehyde sources and in several Heiles dust clouds.

Continuum observations were as follows:

M. Felli (Arcetri, Italy), and E. Churchwell (Indiana)	1400 MHz observations of Sharpless H II regions.
W. Altenhoff (Max Planck Institut für Radioastronomie, Germany)	Mapping of the Rosette Nebula at 1400 MHz.

A. Bridle (Queen's University)  
and M. Davis

1400 MHz survey of sources down to 2.5 flux  
units over a large area of the sky.

E. Seaquist (Toronto) and H. Ross  
(Toronto)

750 and 1400 MHz observations to support  
data collected at the Algonquin Radio Ob-  
servatory of the spectra, polarization,  
and variation of about 60 radio sources.

Observations using equipment designed for pulsar studies were as follows:

<u>Observer</u>	<u>Program</u>
J. Sutton, D. Staelin (M.I.T.), B. Burke (M.I.T.), M. Price (M.I.T.), and E. Reifenstein	Observations of known pulsars at 111-200 MHz and 405 MHz to determine their fre- quency and time structure, and polarization properties, and a search for new sources exhibiting pulsar-like characteristics.

140-foot Telescope

	<u>Hours</u>
Scheduled observing	2069.00
Scheduled maintenance and equipment changes	139.00
Time lost due to: equipment failure	89.75
power	2.50
weather	0.00
interference	8.75

Line observations were conducted as follows:

<u>Observer</u>	<u>Program</u>
J. Simpson (Berkeley)	Study of the detailed shape and structure of hydrogen recombination lines.
G. Verschuur	Measurements of the Zeeman splitting of 21-cm lines in selected sources.
G. Knapp (Maryland)	High frequency resolution observations of possible H-line self-absorption in the direction of dust clouds, and supple- mental OH observations to provide infor- mation about the expected velocity and turbulent effects in the observed regions.
G. Verschuur and M. Felli (Arcetri, Italy)	A search in nearby groups of galaxies for intergalactic H I regions in the form of high-velocity clouds.
M. Roberts	H-line observations of galaxies at faint brightness temperature levels to determine the extent of material associated with galaxies.

- K. Riegel (UCLA) Observations in the general area of W31 to verify the existence of a large angular diameter cloud of very cold neutral hydrogen gas.
- B. Zuckerman (Maryland) and J. Ball (Harvard) Observations of C166 $\alpha$ , O<sup>16</sup>H in absorption in the direction of M31, and time variations and polarization of known O<sup>16</sup>H sources. Search for the formic acid (H<sub>2</sub>CO<sub>2</sub>) molecule, O<sup>18</sup>H in absorption and emission, O<sup>17</sup>H in the direction of the galactic center.
- G. Verschuur and C. Heiles (Berkeley) Measurements of the location, angular diameter, kinetic temperature, and optical depth of several H I clouds.
- A. Penzias (Bell Labs) Continuation of a search for intergalactic H I absorption features.
- C. Gordon and K. Gordon Observations of 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 their amplitudes and pulse shapes.
- A. Barrett (M.I.T.) and W. Wilson (M.I.T.) An extension of a previous survey of OH in infrared stars and monitoring the properties of previously discovered infrared OH sources.
- A. Sandqvist (Maryland) High-resolution absorption spectral studies of OH in Cas A, Cyg A, Sgr A, and Tau A.
- R. Davies (Jodrell Bank, England) OH data to supplement that taken at Jodrell Bank and other observatories regarding the time variability in multiple sources, W75, W33, and NGC 6334, and the measurement of the spin temperature of OH near NGC 2024.
- B. Turner Observations of the 1612, 1667, and 1720 MHz OH lines and the measurement of the Stokes parameters of all four lines in emission in several sources at southern declinations.
- B. Turner Measurements of Stokes parameters with high-frequency resolution of all major ground-state OH lines in Class I and Class II sources; search for O<sup>18</sup>H in emission or absorption and survey for new OH sources in all four ground-state lines.

D. Buhl and B. Turner	An attempt to measure OH radiation from the moon.
P. Mezger and E. Churchwell (Indiana)	Investigation of the H166 $\alpha$ recombination line as it appears in the spectrum of W3, Orion A, M17, NGC 6334, NGC 6357, W43, (W49), W51, and NGC 7538.
J. Lockman (Drexel Institute) and M. Roberts	Observations of the H159 $\alpha$ and H156 $\alpha$ recombination lines in Sgr A.
C. Heiles (Berkeley) and B. Turner	Study of OH emission in dust clouds.
G. Verschuur and B. Turner	Investigation of possible Zeeman line splitting of the OH absorption lines of W12 and Cas A.

Continuum observations were as follows:

<u>Observer</u>	<u>Program</u>
J. Sutton	Lunar occultation of 3C 139.2 at 234, 256, and 405 MHz.
I. Pauliny-Toth and K. Kellermann	Flux densities of variable sources at 4.995 GHz and 15.375 GHz.

### 36-foot Telescope

	<u>Hours</u>
Scheduled observing	264.00
Scheduled maintenance and equipment changes	6.50
Time lost due to: equipment failure	34.50
power	0.00
weather	18.50
interference	0.00

<u>Observer</u>	<u>Program</u>
J. Schraml	Mapping H II regions at 31 GHz.
D. Buhl, A. Tlamicha (Ondrejov, Czechoslovakia), M. Simon (Calif. Inst. of Tech.), and H. Zirin (Calif. Inst. of Tech.)	Solar eclipse observations at 31 and 85 GHz.
M. Kundu (Maryland)	Solar mapping at 31, 85, and 300 GHz.

During the rainy season, July and August, no observing was scheduled on the 36-foot telescope. During that period the following major overhaul and maintenance programs were carried out.

1. The dome door, which had given considerable trouble, was completely overhauled and new, stronger rollers were installed.
2. The reflecting surface of the telescope was painted with white, heat-reflecting paint.

#### 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	4%
Millimeter Receiver Development	6%
Very Long Baseline Interferometer	6%
OH-Line Receiver Construction	9%
Water Vapor Receiver	5%
Pulsar Receiver Construction	6%
3-cm Receiver	2%
6-cm Receiver	4%
413-Channel Correlator	9%
50-Channel Receivers	4%
Visitor Support and Routine Maintenance	30%
21-cm Cooled Paramp	3%
Antenna Measuring Instrument	2%

The dual-channel, low noise OH-line receiver was completed this quarter and has been successfully used on the 140-foot telescope with a system temperature of 70° K.

Progress is continuing on the development of the new 3 cm/11 cm interferometer front-ends. All the parametric amplifiers and one feed have been received. Completion of the front-ends is expected by January 1970.

Contract work on the interferometer delay lines, Schottky-Diode development, a VLB recording and processing system, and a 5 to 10 GHz parametric amplifier system is proceeding satisfactorily. A contract to provide three 21 cm paramps for the interferometer has been completed.

A breadboard of the antenna measuring instrument has been completed, and a stability of 0.002" arc was demonstrated on a 60-foot measurement.

A project to provide a portable front-end for VLB experiments at 2295 MHz was initiated this quarter.

## ENGINEERING DIVISION

During this quarter, the major efforts of the Engineering Division have been concentrated on:

1. The design of a tracking feed mount for the 300-foot telescope which combines polarizing and focusing features.
2. Preparation of specifications for the 300-foot telescope resurfacing.
3. The application of computer reduction to previous survey data taken on the 300-foot telescope. Reduction of data has determined the rms change of the telescope structure from zenith to various positions north and south of zenith as well as the focusing movement required of the feed, and has supported the decision that the dish performance warrants a better surface.
4. Continued design and feasibility studies for the 65-meter homology telescope.
5. Preparation of chapters of a report on the expansion of the Green Bank interferometer.
6. Supervision of dome door modification, dish surface painting, and feed leg measurements of the 36-foot telescope at Kitt Peak.

## ANTENNA DESIGN STUDIES

The Homology Telescope

At the meeting of the ad hoc Advisory Panel on Large Radio Astronomy Facilities (the Dicke Committee) as well as in other discussions with radio astronomers, the need for a large telescope for millimeter wave observations has been emphasized. The homologous principle offers unique possibilities for the design of such a telescope, and the design of a homologous 65 meter telescope which will operate at 6 mm wavelength (0.35 mm rms surface tolerance), or shorter, is being studied.

## JANSKY LECTURE

The fourth annual Karl G. Jansky Lecture was delivered on September 24, 1969 by Professor Fred Hoyle, Plumian Professor of Astronomy and Experimental Philosophy, University of Cambridge, England, on the topic "The Relationship of Astronomy and Physics." Professor Hoyle has made fundamental contributions to astronomy in the areas of nuclear synthesis, star formation, and the later stages of stellar evolution. He is one of the leading proponents of the steady state theory for the origin of the Universe. Besides having contributed numerous papers to the astronomical literature, Professor Hoyle has written more than eight technical books, eight works of fiction, and an opera. His lecture was very well attended. During his week's stay at the NRAO, Dr. Hoyle also spoke at a colloquium entitled "Conformally Invariant Cosmologies."

## PERSONNEL

Appointments

Cary A. Young	Electronic Engineer II	July 21, 1969
Richard N. Manchester	Research Associate	July 30, 1969
John Broderick	Research Associate	July 31, 1969
Ignatius F. Cutitta	Purchasing Manager	August 26, 1969
Mark A. Gordon	Assistant Scientist	September 1, 1969
Takenori Nakano	Visiting Associate Scientist	September 5, 1969
Stephen T. Gottesman	Research Associate	September 9, 1969
Robert L. Brown	Research Associate	September 15, 1969
Edward K. Conklin	Research Associate	September 19, 1969
David S. De Young	Assistant Scientist	September 26, 1969

Terminations

John P. Basart	Research Associate	July 17, 1969
Marcello Felli	Visiting Assistant Scientist	August 28, 1969
Lewis E. Snyder	Research Associate	August 31, 1969
Geoffrey H. Macdonald	Research Associate	September 3, 1969
Alfred J. Burford	Electronic Engineer I	September 30, 1969