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NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report

July 1, 1973 - September 30, 1973

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RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE VA.

NOV 7 1973

RESEARCH PROGRAMS

<u>140-foot Telescope</u>	<u>Hours</u>
Scheduled observing	1960.0
Scheduled maintenance and equipment changes	167.25
Scheduled tests and calibration	64.75
Time lost due to: equipment failure	19.75
power	0.00
weather	1.50
interference	1.00

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
C. Heiles (Berkeley) B. Turner	A comparison of observations of 1665 and 1667-MHz OH with H and H ₂ CO results in a region of Taurus.
F. Kerr (Maryland) P. Bowers (Maryland)	Search at 1662 MHz outside the galactic plane for objects having the OH characteristics of OH/IR stars.
P. Bowers (Maryland)	Search at 1612, 1665, 1667 and 1720 MHz for OH emission from RV Tauri stars.
L. Rickard (Chicago) P. Palmer (Chicago) B. Zuckerman (Berkeley)	Study of excited OH occurring in the range 4660-4765 MHz.
A. Barrett (MIT) R. Martin (MIT)	Observations of CH ₃ OH (methanol) at 5505.37 MHz.
P. Baker	Observations of interstellar filaments at the 6-cm line of H ₂ CO (formaldehyde).
R. Sanders	Search at 4830 MHz for H ₂ CO (formaldehyde) in absorption in M82.
J. Lockman (Massachusetts)	Measurements at 2275 MHz of the H142 α and H178 β -recombination lines in the direction of the galactic center and in HII regions.

<u>Observer</u>	<u>Program</u>
R. Gammon B. Balick	Observations to confirm the possible detection of 158α -recombination lines of H_2^+ , helium, and carbon in Ori A at 18-cm wavelength and of the 85α -recombination line of H_2^+ in Ori A and W3A at 21-cm wavelength.
L. Pataki (Indiana)	Search at 18-cm wavelength for main line emission in late M, Mira-type stars.
L. Rickard (Chicago) P. Palmer (Chicago) B. Zuckerman (Berkeley)	Search for new sources of OH, test of the correlation with Class I OH/ H_2O sources, and polarization studies of known sources at 5-cm wavelength.
T. Arny (Massachusetts) W. Dent (Massachusetts)	Study of Pleiades nebulosity at the 4830-MHz line of H_2CO (formaldehyde).
K. Lo (MIT) P. Myers (MIT) B. Burke (MIT)	Observations of (1) the 4830-MHz H_2CO (formaldehyde) in absorption against HII regions to correlate color excess with H_2CO opacity and (2) the 4874-MHz $H_{110\alpha}$ -recombination line for radial velocity determinations in order to compare results with H_2CO line velocities.
P. Myers (MIT)	Measurements of 4830-MHz H_2CO (formaldehyde) in dusty regions.
M. Wright (Berkeley) J. Silk (Berkeley)	Search for 21-cm neutral hydrogen emission from clusters of galaxies.
W. Boughton (Illinois) J. Dickel (Illinois)	Measurements of the $C168\alpha$ to $C211\alpha$ -recombination line ratios at 22-cm wavelength in Ori A, M17, W3, and Ori B.
J. Dickel (Illinois)	Search for 21-cm hydrogen recombination lines toward supernova remnants which exhibit a low-frequency turnover in their spectra.
C. Heiles (Berkeley) T. Troland (Berkeley)	Polarization measurements of 21-cm neutral hydrogen filaments to attempt to detect Zeeman splitting in emission and a map of 21-cm neutral hydrogen in regions of our galaxy and in M31 and its vicinity for comparison with soft X-ray data.

The following continuum programs were conducted.

<u>Observer</u>	<u>Program</u>
R. Becker (Maryland) M. Kundu (Maryland)	Observations of linear polarization in supernova remnants at 6-cm wavelength.
R. Sramek	Observations at 6-cm wavelength to confirm the detection of 155 normal galaxies and 24 Markarian galaxies at the 300-ft telescope, and to complete the investigation of about 100 additional Markarian galaxies.
M. De Jong (School of the Ozarks)	Search for 6-cm continuum emission from dwarf galaxies which have been detected in the 21-cm line of neutral hydrogen.

The following pulsar observation was conducted.

<u>Observer</u>	<u>Program</u>
D. Backer	Investigation at 5 GHz of the frequency behavior of the scintillation decorrelation time scale and bandwidth of the Vela pulsar.

The following very long baseline observations were conducted.

<u>Observer</u>	<u>Program</u>
A. Moffet (Caltech) M. Cohen (Caltech) R. Schilizzi (Caltech) D. Shaffer (Caltech) G. Swenson (Caltech) I. Pauliny-Toth (Max-Planck Institut für Radioastronomie, W. Germany) K. Kellermann	Observations at 2.8-cm wavelength using the Owens Valley Radio Observatory 130-ft telescope, the Harvard Fort Davis 85-ft telescope, the MPIR Bonn, Germany 100-meter telescope, and the NRAO 140-ft telescope.
T. Clark (NASA, Greenbelt) A. Rogers (Haystack) L. Hutton (Maryland) G. Marandino (Maryland) I. Shapiro (MIT) J. Punsky (MIT) A. Whitney (MIT) D. Robertson (MIT)	Observations at 3.8-cm wavelength to measure source structure, positions and baselines using the Onsala, Sweden 84-ft telescope, the Haystack 120-ft telescope, and the NRAO 140-ft telescopes joined on one day by the Goldstone 210-ft telescope to increase the u-v plane coverage for quasar structure measurements.

<u>Observer</u>	<u>Program</u>
H. Hinteregger (MIT) (continued)	(see previous page)
C. Counselman (MIT)	
O. Rydbeck (Chalmers, Sweden)	
A. Niell (JPL)	
D. Spitzmesser (JPL)	
D. Shaffer (Caltech)	Observations at 2-cm wavelength to measure a number of radio galaxies and quasars to investigate their small scale structure and variation with time using the NRAO 140-ft telescope and the Goldstone 210-ft telescope.
A. Niell (JPL)	
B. Clark	
K. Kellermann	
G. Purcell	
J. Broderick (NAIC, Puerto Rico)	Observations at 430 MHz of a sample of 120-sources which have flux densities greater than 2 flux units at 1400 MHz using the NAIC 1000-ft telescope and the NRAO 140-ft telescope.
J. Condon	

<u>300-foot Telescope</u>	<u>Hours</u>
Scheduled observing	1708.00
Scheduled maintenance and equipment changes	490.75
Scheduled tests and calibration	0.00
Time lost due to: equipment failure	30.75
power	0.00
weather	1.00
interference	8.00

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
R. Tully (Toronto, Canada)	Measurements of 1421-MHz neutral hydrogen in dwarf galaxies and an HI search for optically invisible galaxies.
J. R. Fisher	
R. Brown	Search between 750-1000 MHz for red-shifted 21-cm neutral hydrogen absorption lines in front of quasistellar objects.
M. Roberts	Distribution studies of 21-cm neutral hydrogen in approximately 1000 spiral and elliptical galaxies.
G. S. Shostak	
A. Parrish	Observations of 20-cm H166 α -recombination lines in W49.

<u>Observer</u>	<u>Program</u>
V. Rubin (DTM) M. Roberts	Observations of 1421-MHz neutral hydrogen in 157 ScI galaxies which are in the magnitude range 14.0-15.0.
J. Spencer (NRL) P. Crane (MIT) T. Giuffrida (MIT) B. Burke (MIT)	Measurements of the H246 α -recombination line at 439 MHz and the H247 α -recombination line at 330 MHz in M17, W49, W51, DR21, Orion A and the Rosette Nebula.

The following continuum programs were conducted.

<u>Observer</u>	<u>Program</u>
W. Dent (Massachusetts) J. Kapitzky (Massachusetts)	Monitor of the flux density and polarization of variable radio sources at 2695 MHz.
M. Kesteven (Queens, Canada) A. Bridle (Queens, Canada)	Observations at 2695 MHz to investigate the incidence of variable sources in a complete sample and to study the activity of variable sources at 2695 MHz in comparison with observations at other frequencies.
A. Bridle (Queens, Canada) E. Fomalont	Observations at 1400 MHz to compare the flux density calibration of the Davis Deep Survey and the Westerbork Deep Survey and to produce improved data on Ohio State University Catalog sources.
W. Erickson (Maryland) J. R. Fisher	A 110-1000 MHz study of metric wavelength radio source variability using both the Clark Lake radio telescope and the 300-ft telescope.
F. Owen	Observations of Abell clusters of galaxies at 1400 MHz.

The following pulsar observation was conducted.

<u>Observer</u>	<u>Program</u>
D. Backer	Observations at 400 MHz to attempt to detect a radio pulsar in the center of the Cygnus Loop.

In addition to the above programs, P. Palmer (Chicago) and B. Zuckerman (Berkeley) continued a search near the 21-cm line of neutral hydrogen for intelligent life on planets close to nearby stars.

<u>Interferometer</u>	<u>Hours</u>
Scheduled observing	1760.0
Scheduled maintenance and equipment changes	133.50
Scheduled tests and calibration	314.50
Time lost due to: equipment failure	77.50
power	0.00
weather	20.00
interference	0.00

Unless otherwise indicated, the following continuum observations were conducted at 2695 and 8085 MHz.

<u>Observer</u>	<u>Program</u>
M. Kaftan-Kassim (SUNY, Albany)	Observations of planetary nebulae.
P. Crane (MIT)	Survey of normal spiral galaxies whose diameters exceed a few arc minutes and whose magnitudes are brighter than 12.5.
R. Price (MIT)	
B. Burke (MIT)	Observations of M81, M101, and M31.
T. Giuffrida (MIT)	
J. Spencer (NRL)	
R. Hjellming	Monitor of Cyg X-1.
S. Anand	
J. Hudson	
H. Palmer (Jodrell Bank, England)	Studies of the short-term variability, the flux density and the position of the source 2005+40.
B. Balick	Investigation of the "knots" of radio radiation found in certain HII regions and a survey for such knots in other HII regions using the 45-ft telescope at the 35-km Huntersville site in conjunction with the 85-ft telescopes.
R. Brown	
J. Warner (DTM)	Precise measurements of the positions of radio sources lying near interesting optical objects.
G. Assousa (DTM)	
B. Balick	
P. Palmer (Jodrell Bank, England)	Observations of small compact regions in radio galaxies.
E. Fomalont	Search for unresolved sources over a 35-km baseline to be used in a later general relativity experiment.
R. Sramek	

<u>Observer</u>	<u>Program</u>
J. Wardle (Brandeis) D. Altschuler (Brandeis)	Flux density and polarization measurements of approximately 80 radio sources.
K. Kellermann	Monitor of ≈ 10 sources for radio variability.
R. Hjellming L. Blankenship	Search for X-ray sources.
R. Hobbs (NASA, Greenbelt) W. Webster (NASA, Greenbelt) S. Jordan (NASA, Greenbelt) H. Caulk (NASA, Greenbelt)	Pilot program using the 45-ft telescope over a 35-km baseline to examine fine structure of the sun in limb structures and in active and quiet regions.
M. Kundu (Maryland) T. Velusamy (Maryland)	Observations of the sun using the 45-ft telescope over a 35-km baseline to (1) detect and study spicules, (2) study the fine structure of active regions, and (3) investigate limb brightening.
E. Seaquist (Toronto, Canada)	Observations of a group of 14 spiral galaxies and 5 radio stars.
H. Tovmassian (Byurakan Astrophysical Observatory, Armenia) R. Sramek	Observations of 19 galaxies to test the hypothesis that class 5 galaxies in the Byurakan classification system have radio cores.
R. Hjellming D. Gibson (Virginia)	Observations of radio emission from binary stars.
G. Sistla (SUNY, Albany) S. Hong (SUNY, Albany)	Search for continuum emission from early-type stars.
K. Lang (Caltech)	Observations of the quiet sun and solar flares.
J. Spencer (NRL) P. Schwartz (NRL)	Attempt to detect stars with extended optically thick circumstellar envelopes.
J. Broderick (NAIC) R. Brown	Search for compact sources in intense, far IR objects identified with dark clouds and nebulae.
B. Clark E. Fomalont K. Kellermann	Observations over a 35-km baseline to explore extended radio sources to obtain a sample of sources with compact components suitable for later VLB study.

The following line program was conducted.

<u>Observer</u>	<u>Program</u>
E. Greisen	Partial synthesis of 21-cm neutral hydrogen in absorption.

The following very long baseline observation was conducted.

<u>Observer</u>	<u>Program</u>
M. Harwit (Cornell)	Observations at 8085 MHz of possible differences in the gravitational deflection of orthogonally polarized radiation past the sun utilizing two NRAO 85-ft telescopes and two Owens Valley Radio Observatory 90-ft telescopes.
B. Dennison (Cornell)	
D. Jauncey (Cornell)	
J. Broderick (NAIC)	
R. Schilizzi (Caltech)	
R. Lovelace (Princeton)	

<u>36-foot Telescope</u>	<u>Hours</u>
Scheduled observing	355.50
Scheduled maintenance and equipment changes	1591.50
Scheduled test and calibration	261.00
Time lost due to: telescope and receiver failure	46.25
digital system failure	7.25
power	8.50
weather	57.50
interference	0.00

No observing was scheduled for the period July 18 - September 30 due to seasonal adverse weather, and this time was used for major telescope modifications, including painting of the dome and complete replacement of the protective dome fabric; reconstruction of the fixed and folding doors; overhauling of the dome drive; installation and checkout of a new PDP 11/40 on-line computer, tape, disk, and multiple display system (replacing two older systems); development of improved spectral line and telescope tracking programs; and refurbishment of the telescope control room.

During July 1-18, the following observations were made.

<u>Observer</u>	<u>Program</u>
G. Wrixon (Bell Labs)	Search for carbon monoxide in various sources (230 GHz).
M. Schneider (Bell Labs)	
T. Phillips (Bell Labs)	Survey of carbon monoxide in Orion A, Sgr A and other sources (230 GHz).
K. Jefferts (Bell Labs)	
E. Conklin	Observations of unusual sources from the Ohio State Catalog (31 and 85 GHz continuum).

<u>Observer</u>	<u>Program</u>
E. Conklin	Study of short-period variability and correlation with optical activity in various QSO's (31 and 85 GHz continuum).
H. Johnson (Lockheed)	Study of galactic symmetric and planetary nebulae (31 and 85 GHz continuum).

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

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

15-GHz cooled receiver	4%
0.5-1 GHz receiver	10%
45-ft telescope equipment	10%
VLBI	6%
Interference protection	3%
Antenna development	5%
256-channel multifilter receiver	7%
Visitor support and routine maintenance	24%
Improved LO system	5%
7.8 GHz cooled (Rice) receiver	4%
Cooled mixer receiver	10%
85-GHz Cassegrain receiver	6%
140-ft Cassegrain receiver	6%

An 85-GHz continuum receiver, 256 x 1 MHz comb filter bank, and 256 x 0.25 MHz filter bank have been completed this quarter and put into service at the 36-ft telescope. The nutating subreflector for the 36-ft telescope has also been completed. Improvements in the 7.8 GHz receiver have been completed.

Work is continuing on the 36-ft cooled mixer receiver, additional filter banks, the 0.5 to 0.74 GHz receiver, and the 140-ft Cassegrain receiver. The 18-21-cm parametric up-converter has recently been delivered and contract work on the 6 mm and 11-cm paramps is continuing.

ENGINEERING DIVISION

140-ft Antenna - Continuing design and supervision of construction of a vertex building for a Cassegrain system. Completion of drawings and specifications for a new Sterling mount. Completion of specifications and assistance in securing quotations for an air conditioning system for the new vertex building.

300-ft Antenna - Supervision of painting of the structure. The painting was completed this quarter.

Paint Shop--Green Bank - Supervision and assistance in the installation of mechanical equipment and completion of the building.

Indoor-Outdoor Test Facility, Green Bank - Supervision and assistance in the installation of mechanical equipment and completion of the building.

36-ft Antenna - Supervision of completion of installation of new dome cover, new door cover and repairs to overhead door.

COMPUTER DIVISION

Computer Procurements - A Dicomed D47 color graphics unit has been procured. The device will produce color or gray scale maps of up to 4096 points on a side. The output media is 105 mm film.

Interferometer - The standard operating system now in use at the interferometer supports four elements. Off-line preliminary programs are now available for full reduction.

VERY LARGE ARRAY

Funding - Both the House and Senate Authorization Committees authorized FY 1974 funds for the VLA. The House Appropriation Committee recommended that FY 1974 funding of the VLA be deferred; however, the Senate Appropriations Committee restored the funding at the requested \$10 million level. A House-Senate Conference Committee then provided \$5,000,000 to commence construction of the Very Large Array. Both Houses have accepted the Conference Committee report as it pertains to funding, but are currently in disagreement as to an amendment to the bill that does not involve the VLA. It is not known when final action on the bill will occur.

Land Acquisition - The U.S. Corps of Engineers has completed all appraisal work for the central site and wye arms. Condemnation papers for the 640 acre central site have been prepared and sent to the NSF for approval. The Foundation is holding up all action on land acquisition pending Congressional approval of FY 1974 NSF appropriations.

Design Activities - A model cooled front end assembly is expected to be completed during October 1973. Two hundred meters of 60 mm circular waveguide has been tested. The data taken on the Green Bank test stand shows that both waveguide manufacturers are meeting specifications.

Engineer-Architect - After a review meeting with the E/A on September 12 and 13, general approval was given to the concepts proposed. All soil exploration work has been completed and the railroad construction has been selected.

Major Procurement Activities

Antenna - "Best and Final" prices have been received. These were reviewed and a recommendation of award made to the NSF. We have been advised that

Foundation approval will be held until they are assured of FY 1974 funding.

Continuum Computer - Commerce Business Daily ad was placed August 9, 1973. An RFP has been issued to seventeen firms. Proposals are due in early November.

Antenna Transporter - An RFP has been issued to twenty-five firms. Proposals are due in early November.

Digital Communications System - An RFP has been issued to 36 firms. Two proposals have been received which are now under evaluation.

Digital and Delay Multilayer P.C. Boards - An RFP has been issued to ten firms. Proposals are due in early October.

Miscellaneous

Electric Utility - Negotiations have begun with the Socorro Electric Co-operative covering the furnishing of electric power. SEC has agreed to construct an express 25 kV feeder from Magdalena for our exclusive use.

Staffing - The VLA staff, on September 30, totalled thirty-two people.

PERSONNEL

Appointments

Surendra P. S. Anand	Vis. Asst. Scientist	7/9/73
Robert E. Dorr	Business Manager - VLA	8/15/73
George H. Purcell, Jr.	Research Associate	8/24/73
Frazer N. Owen	Research Associate	8/29/73
*Monroe E. Petty	Personnel Manager	9/1/73
*Emory G. Egler	Construction Eng. - VLA	9/1/73
Jan M. Hollis	Scient. Prog. Analyst	9/1/73
John G. Lyon	Research Associate	9/19/73

Terminations

James E. Finks, Jr.	Business Manager - VLA	7/20/73
Bruce Balick	Research Associate	8/16/73
Gerrit L. Verschuur	Associate Scientist	8/31/73
Donald C. Backer	Research Associate	8/31/73
Henry P. Palmer	Visiting Scientist	9/26/73
Paul L. Baker	Research Associate	9/30/73

Deaths

Bruce K. Nottingham	Asst. Plant Maint. Supv.	8/3/73
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* Transfers from Brookhaven National Laboratory.