NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report

January 1, 1978 - March 31, 1978

RESEARCH PROGRAMS

140-Foot Telescope		Hours
Scheduled observing		1858.00
Scheduled maintenance and equipment changes		165.00
Scheduled tests and calibration		121.00
Time lost due to:	equipment failure	48.50
	power	3.75
	weather	37.50
	interference	1.00

The following line programs were conducted during this quarter.

Observer	Program
R. Spencer (Jodrell Bank, U.K.) R. Brown	Search for redshifted 21-cm hydrogen absorption in the quasar 3C 48.
L. Rickard	Search at 1047 MHz for H_2CS (thioformaldehyde) in anomalous absorption in dust clouds.
S. Gottesman (Florida) D. W. Johnson (Florida)	Observations at 1425 MHz to search for H166α in the galaxies NGC 253, 1068, 1275, 3034, 4486, and 5128.
M. Haynes (Indiana) M. Roberts	Observations to complete the study of 21-cm hydrogen in the Sculptor group of galaxies.
R. Whitehurst (Alabama) M. Roberts	Study of an extended feature of 21-cm hydrogen found in the northern part of M31.
F. J. Lockman (DTM)	Observations of 21-cm H166α recombination line emission to study the bulk motion in the ionized gas near the Rosette nebula.

Observer	Program
R. Tully (Hawaii) J. R. Fisher	Observations to continue the survey of 21-cm hydrogen in nearby galaxies.
F. J. Lockman (DTM) R. Brown	Observations of 21-cm neutral hydrogen and the 21-cm H166α recombination line in the Cyg X region.
T. Wilson (MPIR, Bonn, W. Germany) R. Rood (Virginia)	Study of 3.7-cm high-order recombination lines in NGC 7027.
A. P. Henderson (Manhattan College)	Preliminary study at 2.8-cm of selected HII regions to test the LSR velocity dependence on recombination line number in those sources.
P. Ekstrom (Battelle) K. Davis (Battelle) R. Gammon (Washington) R. Loren (Texas) H. Wootten (Texas)	Observations at 2.8-cm to search for C85α and H85α toward selected Herbig Be and Ae stars and other early-type stars associated with dust clouds.
R. Brown D. DeYoung L. Rudnick	Observations at 2.8-cm to confirm the detection of H85α in one component of Cyg A and to determine whether H85α exists in another component of Cyg A.
C. Heiles (Berkeley) T. Troland (Berkeley)	Search at 21-cm for the Zeeman effect in Cent A, Per A, and in the galactic center.
E. Grayzeck (Nevada) A. P. Henderson (Manhattan College)	Search for 21-cm high-velocity hydrogen possibly associated with an encounter between the Galaxy and the Magellanic Clouds.
P. Vanden Bout (Texas)	Search for the carbon monoxide dimer at 1457.797 MHz and observations of 21-cm hydrogen in dark clouds.
L. DeNoyer (Cornell)	Study of 6-cm H_2CO in molecular clouds near supernova remnants.
M. Kutner (Rensselaer) W. Massano (Fordham) K. Tucker (Fordham)	Observations at 4388.8 MHz of $H_2C^{18}O$ to obtain a measure of the "double" ratio $[^{12}C^{18}O]/[^{13}C^{16}O]$.

The following continuum programs were conducted.

Observer	Program
R. Dickman (Aerospace) R. Hobbs (Goddard) S. Maran (Goddard) M. Jura (UCLA) M. Wright (UCLA)	Observations at 2.8 cm to measure the radiation from the emission nebula around T Tauri stars, and observations of 3C 111.
L. Rudnick	Observations at 10.522 GHz to verify and map hot gas in clusters of galaxies.
H. Quintana L. Rudnick	Search at 6 cm for the radio/optical counterparts of high galactic latitude, unidentified x-ray sources.
M. Ruiz (Instituto de Astronomia Universidad Nacional Autonoma de Mexico)	Mapping at 5006 MHz of the 8° x 10° region containing the supernova remnants VRO 42.0501, HB9, OA814, and CTB13.
J. van der Hulst	Mapping at 5006 MHz of 30 nearby galaxies.

The following very long baseline programs were conducted, and the stations used in the experiments are coded as follows:

A - Algonquin, Canada 150-ft	J - Goldstone 210-ft
B - MPIR, Bonn, W. Germany 100 m	K - Haystack 120-ft
E - Jodrell Bank, U.K. 250-ft	M - DSN, Madrid, Spain 210-ft
F - Harvard, Fort Davis 85-ft	N - NRL 85-ft
G - NRAO 140-ft	O - OVRO 130-ft
GB - NRAO 300-ft	P - Arecibo 1000-ft
H - Hat Creek 85-ft	S - Onsala, Sweden 24-m

Observer	Program
B. Geldzahler (Pennsylvania) K. Kellermann (MPIR, Bonn, W. Germany) R. Brown M. Reid D. Shaffer	Observations to search for 21-cm hydrogen absorption in the source CL4, using telescopes at B, P, G, and GB.
K. Lo (Berkeley)	Observations at 3.7 cm of the structure of the galactic center using telescopes at stations J, O, H, K, and G.

Observer	Program
J. Ball (Center for Astrophys.) J. Moran (Center for Astrophys.) K. Johnston (NRL) M. Reid	Spectral line 18-cm OH observations to measure the absolute positions and the structure of OH masers using telescopes N, F, and G.
A. Marscher (Goddard) D. Shaffer	Observations at 2.8-cm and 18-cm of selected sources using telescopes, O, F, and G.
J. Broderick (VPI & SU) J. Condon (VPI & SU) B. Dennison (VPI & SU) T. Jones (Minnesota) R. Brown	Observations of selected BL Lac objects and flat spectrum sources at 2.8-cm using telescopes K, O, and G.
K. Johnston (NRL) A. Wolfe (Pittsburgh) R. Brown	Monitor 3C 446 at 2.8-cm using telescopes K, O, and G.
N. Broten (NRC, Canada) D. Fort (NRC, Canada) J. Yen (Toronto, Canada) K. Kellermann (MPIR, Bonn, W. Germany) S. Knowles (NRL) W. Waltman (NRL) G. Swenson (Illinois) B. Rayhrer	Observations at 2.8-cm using the A and G telescopes, with the G telescope data transmitted from the NRAO 85-1 telescope to the Canadian CTS geostationary satellite and thence to Algonquin, Canada to permit on-line data analysis.
K. Weiler (MPIR, Bonn, W. Germany) K. Johnston (NRL)	Observations at 6-cm to determine the size of BL Lac objects using telescopes B and G.
K. Kellermann (MPIR, Bonn, W. Germany) I. Pauliny-Toth (MPIR, Bonn, W. Germany) E. Preuss (MPIR, Bonn, W. Germany) M. Reid D. Shaffer	Observations at 6-cm of extended elliptical galaxies, quasars, and radio galaxies using the B, O, and G telescopes.
A. Readhead (Caltech) P. Wilkinson (Caltech)	Observations at 610 MHz to recheck for decimetric flux density variations of selected sources using E, O, K, and G telescopes.

Observer	Program
W. Cotton (MIT) M. Ratner (MIT) I. Shapiro (MIT) J. Wittels (MIT) C. Knight (Haystack) T. Clark (Goddard)	Observations at 2.6, 3.6, 13, and 50-cm to check for aligned structure in source components of different ages and sizes, to look for non-uniform components and to examine some steep spectrum sources using telescopes at M, S, J, O, F, K, and G.
M. Cohen (Caltech) R. Linfield (Caltech) A. Moffet (Caltech) A. Readhead (Caltech) J. Romney (Caltech) G. Seielstad (Caltech)	Monitor selected sources at 2.8-cm using the F, O, and G telescopes.

300-Foot Telescope		Hours
Scheduled observing		1888.50
Scheduled maintenance and equipment changes		145.25
Scheduled tests and calibration		0.00
Time lost due to:	equipment failure	42.50
	power	1.00
	weather	15.25
	interference	10.00

The following line programs were conducted during this quarter.

Observer	Program
A. Haschick (MIT) P. Crane	Study of the variability of 21-cm hydrogen absorption in 3C 84.
R. M. Price (NSF) P. Crane	Study 21-cm hydrogen in galaxies having compact nuclei.
A. Rots (Netherlands Foundation for Radio Astronomy) P. Crane	Observations to complete the mapping of nearby galaxies in 21-cm hydrogen.
P. Crane	Study 21-cm hydrogen in a complete sample of spiral galaxies.
A. Marscher (Goddard) R. Brown	Search for highly redshifted 21-cm hydrogen absorption in quasars between frequencies of 740 and 1000 MHz.

Observer	Program
F. Briggs (Pittsburgh) A. Wolfe (Pittsburgh) K. Johnston (NRL) R. Brown	Observations at 760 MHz of 3C 446 in a search for redshifted 21-cm hydrogen in absorption.

The following continuum programs were conducted.

Observer	Program
W. Cotton (MIT) S. Mufson (Indiana) F. Owen S. Spangler	Observations of extragalactic flat spectrum sources at 775 and 968 MHz.
L. Rudnick	Observations at 6 cm to search for low temperature ionized gas in groups and clusters of galaxies.
M. Adams (Arizona) E. Jensen (Rice) J. Stocke (UCLA)	Survey at 6 cm of a large sample of isolated galaxies selected from the Karachentseva catalog.
W. Cotton (MIT) S. Spangler	Observations at 1400 MHz to study sources that are low-frequency variable candidates and at three discrete frequencies between 320 and 450 MHz to study low-frequency variable sources.
B. Dennison (VPI & SU)	Polarization measurements at 9 cm of radio sources that are located within and behind clusters of galaxies.
G. Rossano (Maryland)	Study at 9 cm of diffuse envelopes surrounding dark cloud complexes.

The following pulsar programs were conducted.

Observer	Program
M. Damashek (Massachusetts) J. Taylor (Massachusetts)	Observations to complete a northern hemisphere pulsar search at 410 MHz.

The following very long baseline observations were conducted.

Observer	Program
K. Kellermann (MPIR, Bonn, W. Germany) B. Geldzahler (Pennsylvania) R. Brown M. Reid D. Shaffer	Observations to search for 21-cm hydrogen absorption in the source CL4 using the MPIR 100-meter telescope, the Arecibo 1000-foot telescope, and the NRAO 140-foot and 300-foot telescopes.

Interferometer	Hours
Scheduled observing	1946.00
Scheduled maintenance and equipment changes	117.75
Scheduled tests and calibration	80.25
Time lost due to: equipment failure	40.25
power	4.50
weather	82.00
interference	0.00

While several programs used the 45-foot over a 35-km baseline, only those specifically requiring its use are indicated in the program description.

The following continuum programs were conducted at 2695 and 8085 MHz, unless otherwise noted.

Observer	Program
R. M. Price (NSF) P. Crane	High-resolution studies of spiral galaxies.
D. Backer (Berkeley) R. Sramek (Arecibo)	Proper motion studies and parallax studies of pulsars and radio stars using the 45-foot telescope.
D. Altschuler (Inter-American U., Puerto Rico) J. Wardle (Brandeis)	Monitor the variability of flux and polarization in approximately 80 sources.
E. Seaquist (Toronto, Canada) P. Crane	Mapping of the radio emission from normal spiral galaxies.
K. Kellermann (MPIR, Bonn, W. Germany) J. Broderick (VPI & SU) B. Geldzahler (Pennsylvania) R. Brown	Studies of small diameter sources found at low galactic latitude.

Observer	Program
J. Burns (Indiana) F. Owen L. Rudnick	Detailed mapping of selected head-tail radio sources using the 45-foot telescope.
L. Rudnick	Observations of extended structures in selected 4C sources.
J. van der Hulst P. Crane	Observations of the Sb galaxy NGC 4102 using the 45-foot telescope.
K. Johnston (NRL) C. Mayer (NRL) J. Spencer (NRL) G. Kaplan (USNO) W. Klepczynski (USNO) D. McCarthy (USNO) G. Westerhout (USNO)	Observations to determine UT and polar motion using the 45-foot telescope.
K. Lo (Berkeley) R. Brown	Very high-resolution monitoring of the time-flux variability of Sgr A using the 45-foot telescope.
S. Gottesman (Florida) D. Florkowski (Florida)	Observations of the mass loss from HD 193793 using the 45-foot telescope.
R. Brown	Mapping S140-R and NGC 2023.
J. Krassner (Rochester) J. Pipher (Rochester) M. Savedoff (Rochester)	Observations of compact HII regions.
F. J. Lockman (DTM) R. Brown	Observations with the 45-foot to determine the visibility function of approximately 40 HII regions whose line emission is currently being studied.
J. Burns (Indiana) F. Owen	Study of radio sources in Zwicky clusters of galaxies.
B. Dennison (VPI & SU)	Measurements of the Faraday rotations of radio sources located within and behind clusters of galaxies.

Observer	Program
H. Johnson (Lockheed)	Measurements of the distribution of emission in the clusters Abell 401 and Abell 2142 and an attempt to measure emission from SA015338.
R. Rood (Virginia) H. Martin (Haverford) R. Partridge (Haverford)	Observations to search for fluctuations in the cosmic microwave background.
J. Brandt (Goddard) R. Hobbs (Goddard) S. Maran (Goddard)	Study of comet 1978c at 8085 MHz only.

In addition to the above, the 85-1 telescope was used as a link with the CTS Canadian satellite to transmit VLB data from the NRAO 140-foot telescope to Algonquin, Canada.

36-Foot Telescope		Hours
Scheduled observing		1931.75
Scheduled maintenance and equipment changes		127.25
Scheduled tests and calibration		77.00
Time lost due to:	equipment failure	25.50
	weather	446.75
	power	5.00
	interference	0.25

Observer	Program
B. Andrew (Herzberg Institute) E. Epstein (Aerospace) W. Wilson (Aerospace) F. Palluconi (JPL) H. Kieffer (UCLA) F. Briggs (NAIC)	A measurement of the longitude dependence of the brightness of Mars.
L. Avery (Herzberg Institute) N. Broten (Herzberg Institute) J. MacLeod (Herzberg Institute) T. Oka (Herzberg Institute) H. Kroto (Sussex, U.K.)	Follow up of cyanohextriyne detection.
T. Bania (NAIC)	Study of the 3-kpc arm of the galaxy in CO emission.

Observer	Program
A. Barrett (MIT) R. Buxton (MIT) M. Schneps (MIT) P. Ho (Massachusetts)	Observations of CO in interstellar gas bubbles.
P. Bierman (Bonn, W. Germany) T. Wilson (MPIR, Bonn, W. Germany) K. Fricke (Gottingen, W. Germany)	Observations of Markarian and Seyfert galaxies.
D. Blake (Chicago) P. Palmer (Chicago)	Study of deuterium enhancement using deuterated ammonia.
W. B. Burton H. Liszt P. Baker (MPIR, Bonn, W. Germany)	Correlation of CO and HI emission near the galactic plane.
W. Dent (Massachusetts) R. Hobbs (Goddard)	Evolution of extragalactic radio sources at millimeter wavelengths.
D. Dickinson (Center for Astrophys.) C. Gottlieb (Center for Astrophys.) M. Reid	A study of SiO emission in molecular clouds near IR sources.
E. Epstein (Aerospace) J. Rather (W. J. Schafer Assoc., Inc.)	A study of intraday variability in BL-Lac and other sources.
R. Gammon (Washington) B. Turner	A search for rings and saturated hydrocarbons to test models of interstellar chemistry.
P. Goldsmith (Massachusetts) R. Linke (Bell Labs)	Carbon monosulfide as an indicator of electron density in interstellar clouds.
C. Gottlieb (Center for Astrophys.) E. Gottlieb (Center for Astrophys.)	Attempt to estimate the C^+ abundance from SO, SO_2 and OH.
C. Gottlieb (Center for Astrophys.) M. Oppenheimer (Center for Astrophys.) C. Lada (Center for Astrophys.)	A search for CCO and further studies of OCS.
R. Hobbs (Goddard) R. Sinha (Maryland) P. Marionni (Maryland)	Observations of planetary nebulae.

Observer	Program
R. Hobbs (Goddard) F. Kerr (Maryland) R. Sinha (Maryland)	A map of the galactic center at 90 GHz.
A. Kislyakov (Gorky Radio Phys. Inst.)	Further exploration of the unidentified line at 102.5 GHz.
A. Kislyakov (Gorky Radio Phys. Inst.) M. Gordon	CO observations of dust clouds exhibiting continuum emission.
C. Kumar (Howard)	Radio frequency search for CO in nova ejecta.
H. Liszt B. Turner	A search for 2-mm spectrum of nitric oxide.
F. Owen S. Spangler W. Cotton (MIT) S. Mufson (Indiana)	Multifrequency observations of flat spectrum sources.
L. Rickard B. Turner P. Palmer (Chicago)	Continued study of CO emission from galaxies.
N. Scoville (Massachusetts) P. Solomon (SUNY, Stony Brook) D. Sanders (SUNY, Stony Brook)	Study of the v = 1 CO emission from stars.
M. Simon (SUNY, Stony Brook) G. Righini-Cohen (SUNY, Stony Brook)	Continuum observations of HII regions and molecular clouds.
L. Snyder (Illinois) J. Hollis B. Ulich F. Lovas (NBS)	An attempt to detect gas phase compounds phosphorus nitride and phosphine.
P. Solomon (SUNY, Stony Brook) D. Sanders (SUNY, Stony Brook) N. Scoville (Massachusetts)	High-resolution observations of giant molecular clouds in CO.
P. Solomon (SUNY, Stony Brook) G. Rieke (Arizona)	Dynamics of star formation regions.

Observer	Program
L. Weliachew (Observatoire de Paris) F. Combes (Observatoire de Paris) R. Lucas (Observatoire de Paris) P. Encrenaz (Observatoire de Paris)	Study of M31 and other spiral galaxies in CO emission.
H. Wootten (Texas) P. Vanden Bout (Texas) N. Evans (Texas) R. Snell (Texas)	Determination of electron densities in molecular clouds using H_2CO, HCO^+ and DCO^+.

ELECTRONICS DIVISION

Charlottesville

Development of the Model IV autocorrelator is progressing. The computer has been checked out and programming is underway. The custom made chips have been received and checked out, and the few non-operative chips have been returned to the manufacturer for evaluation.

The VLB Mark III formatter has been completed and one unit has been sent to Haystack for evaluation. The first record terminal is being completed and most parts have been ordered for the second terminal.

The Millimeter Group has been building 2-mm mixers and assembling S. Weinreb's downconverters. A second independently biased harmonically-pumped mixer has been built and is about to be tested.

Green Bank

A Mark II VLB data quality analyzer has been completed and is in operation in Green Bank. This unit will display the number of parity, BOF, frame count and drop-out errors over selectable periods of 1, 10 or 60s. It also decodes the audio track to display the time information. The signal to be analyzed can be either from the read-after-write head on the IVC recorder or from playback on either the IVC or Ampex recorder. The data quality analyzer is described in EDIR No. 185.

The Mark III digital continuum back end has undergone preliminary tests at the 300-foot to test data transfer formats and electronics. For the present an HP 9825A calculator is being used in this unit, and an integration time as short as 0.3 s can be achieved with four channels in the Dicke switch mode with continuous gain calibration.

Six surplus Ampex VR 660 recorders were received from NASA, and we are in the process of repairing as many as can be salvaged for spares and use at other observatories.

Work on a single sideband mixer for the VLA is nearly completed.

The stability of the 11-cm continuum receiver has been greatly improved by replacing some IF amplifiers, and the spurious front-end switch problems in the 2.8-cm receiver appear to have been isolated. A number of 5 GHz Comtech paramps are being repaired for use as spares in Tucson and Green Bank.

Acceptance tests were performed at AIL on the 8.2 and 10.8 GHz upconverter and delivery is expected in early April. Systems work is proceeding on the 5-16 GHz Cassegrain receiver and upconverters will be added as they arrive. Systems work and upconverter development is also underway on the 0.3 to 1.0 GHz receiver.

The VLA prototype front-end which has been in use on the 140-foot for several years was retired in March to make room for the maser development.

Tucson

During this quarter the computer controlled local oscillator system has been installed at the telescope.

Both the new 80-120 GHz/33-50 GHz and the 130-170 GHz receivers have been used for observing during this quarter. The 130-170 GHz mixers are still not working as well as was hoped, and the receiver has been withdrawn from service in order to permit study of the problem.

The second 1 MHz, 256-channel filter bank is almost completed and will be tested on the telescope during the next quarter.

ENGINEERING DIVISION

Design for a new traveling feed system for the 300-foot telescope continued, with emphasis on the readout and drive system. The study for a measurement system for the surface of the 140-foot telescope moved forward, and work orders were placed with the shop for equipment, tools, and attachments to be used on the telescope. Fabrication and assembly of the activating system for the deformable subreflector was completed and performance and electronics tests were started in preparation for installation on the telescope. Conceptual design and structural analysis was carried forward for a future 25-m millimeter wavelength telescope and astrodome, along with research and study of other factors relative to the telescope, astrodome and

site. Routine engineering assistance was provided operations and maintenance in Charlottesville, Green Bank, and Tucson.

COMPUTER DIVISION

Map Processing Development

An interactive, image-oriented map processing system to run principally on the Charlottesville Modcomp computer is being developed. This system will be used initially for VLA post-processing, but will also be available for other kinds of astronomical map processing, including VLBI and single dish observations. The purchasing process has begun for large disks, a television-like display processor, and an array processor. The fundamental routines needed to handle user/computer communication and data movement and management are now working. The program is called NIPS for NRAO Image Processing System.

300-Foot Telescope

Development has continued on the 300-foot quick-look continuum system (CONDARE). Most one-dimensional verbs available in the Charlottesville Condare program are available in the 300-foot Condare program. Also the 300-foot Condare program has been expanded to include multiple data files increasing the number of scans that can be stored on disk from 2400 to 9600.

VLBI

Further work was done on organizing and developing a standard program package for spectral-line VLBI obserations. Previously, post-processing on VLBI spectral-line observations made use of private programs not supported by the Computer Division.

360 System

Work has begun on connecting the 360 system to the Modcomp IV computer to facilitate passing data between the two systems. The Modcomp IV system is being developed especially for map processing.

VERY LARGE ARRAY PROGRAM

The array was scheduled for 908 hours of tests and observations during the first quarter of 1978. By the end of the quarter, the array was operating with eleven antennas on a baseline of 10.5 km. Sixteen antennas have been accepted from E-Systems as of the end of March.

The electronics group pressurized the waveguide for the first time on February 14. The manifold-regulator system for introducing the nitrogen gas into the waveguide performed satisfactorily. The current retrofit program covering most of the required local oscillator modifications has now been completed on all antennas except 2, 4, and 6. Three production run refrigerator-compressor systems were received from Cryogenics Technology, Inc. and will be used on front ends 13, 14, and 15. The first fringes were obtained on Antenna 11 on February 1, 1978 and on Antenna 12 on March 27, 1978.

In the computer area a study group has been set up to formulate configuration and specifications for the spectral-line system sorting system. By the end of the quarter the group has nearly completed their study and will issue a final report in early April. A review of film output devices for map output has begun, with procurement anticipated this spring.

The question of applicable Davis-Bacon wage rates was resolved favorably, and the final wage determination was published by the Department of Labor on March 10, 1978. Preparations are underway to issue the bid package for an amended Phase IV construction of track and foundations, using this determination.

The archaeologists from New Mexico State University commenced their dig on the southwest arm on February 20. The work is proceeding well at the end of the quarter.

PERSONNEL

Promotions

Peter J. Napier	To Division Head - VLA Electronics	3/01/78