NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report

July 1, 1974 - September 30, 1974

RESEARCH PROGRAMS

		Hours
140-foot Telescope		
Scheduled Observing		963.75
Scheduled Maintenance and Equipment Changes		1217.00
Scheduled Tests and Calibration		27.25
Time Lost Due to:	Equipment Failure	18.25
	Power	1.00
	Weather	23.25
	Interference	0.00

The following line programs were conducted during this quarter.

Observer	Program
K. Gordon (Hampshire College) C. Gordon (Hampshire College) S. Kleiner (Massachusetts)	Measurement of 21-cm neutral hydrogen absorption of pulsar radiation.
G. S. Shostak	Neutral hydrogen observations at 21-cm wavelength of galaxy companions and compact galactic groups; absorption measurements of 21-cm neutral hydrogen in NGC 1068.
R. Sinha (Maryland) S. Simonson (Maryland)	Complete 21-cm neutral hydrogen survey of the galactic center between longitudes 340° and 12°, with a latitude extent of 4°.
W. Boughton (Illinois)	Observations at 21-cm wavelength of the C211β recombination line in Ori A, Ori B and W3.
P. Baker (NASA-Greenbelt)	Observations of the spatial spectrum of turbulence and the energy content of local 21-cm neutral hydrogen gas.
R. B. Tully (Observatoire de Marseille, France) J. R. Fisher	Extension of a 21-cm neutral hydrogen survey of galaxies to declinations south of those attainable at the 300-ft telescope.

Observer	Program
J. Dickel (Illinois)	Observations of 21-cm carbon recombination lines in supernova remnants.
B. Turner	Map 18-cm OH emission in the galaxy and from Herbig-Haro objects and cometary nebulae.
C. Heiles (U. California, Berkeley) T. Troland (U. California, Berkeley)	Observations at 21-cm wavelength to confirm the detection of Zeeman splitting of neutral hydrogen and to search for the effect in other regions.
K. Turner (DTM) J. Erkes (SUNY-Albany) L. DeNoyer (Illinois)	Observations at the 21-cm line of neutral hydrogen to measure magnetic fields near the supernova remnants HB21 and W44.

The following continuum observations were conducted.

Observer	Program
D. Wilkinson (Princeton) L. Rudnick (Princeton) P.J.E. Peebles (U. California, Berkeley)	Map at 2.8 cm the plasma in galactic clusters from the scattering of 2.7° K radiation.
S. Gottesman (Florida) T. Carr (Florida) M. Desch (Florida) R. Flagg (Florida) G. Lebo (Florida) M. Lynch (Florida) F. Maloney (Florida)	Lunar occultation observations of the Crab Nebula at 111 MHz.

The following very long baseline observations were conducted.

Observer	Program
M. Cohen (Caltech) R. Schilizzi (Caltech) J. Romney (Caltech) A. Moffet (Caltech) I. Pauliny-Toth (MPIR, W. Germany) E. Preuss (MPIR, W. Germany) A. Witzel (MPIR, W. Germany) N. Broten (NRC, Canada) J. Yen (NRC, Canada) D. Fort (NRC, Canada) D. Shaffer (Yale) R. Rhinehart (Harvard-Fort Davis) G. Purcell K. Kellermann	Observations at 2.8-cm wavelength using the OVRO 130-ft telescope, the MPIR, W. Germany 100-m telescope, the Algonquin Radio Observatory, Canada 150-ft telescope, and the NRAO 140-ft telescope.

Observer	Program
T. Clark (NASA-Greenbelt) A. Rogers (Haystack Observatory) L. Hutton (Maryland) G. Marandino (Maryland) I. Shapiro (MIT) J. Punsky (MIT) D. Robertson (MIT) A. Whitney (MIT) H. Hinteregger (MIT) C. Counselman (MIT) A. Niell (JPL) D. Spitzmesser (JPL)	Observations at 3.8-cm wavelength of the structure of quasars and related objects and for performing geodetic and astrometric studies using the NASA-Goldstone 210-ft telescope, the Haystack 120-ft telescope, the Chalmers, Sweden 84-ft telescope, and the NRAO 140-ft telescope.
J. Romney (Caltech) R. Schilizzi (Caltech) N. Dieter (U. California, Berkeley) W. Welch (U. California, Berkeley) D. Shaffer (Yale)	Observations to study the fine structure of Perseus A in the 21-cm line of neutral hydrogen and in 21-cm continuum using the OVRO 130-ft telescope, the Hat Creek 85-ft telescope, and the NRAO 140-ft telescope.

In addition to the above programs, B. Turner and J. Dolan made measurements to determine the impact of the SMS-1 synchronous satellite transmissions upon the 1660-1670 MHz radio astronomy band.

In mid-August the 140-ft telescope was removed from operation to undergo modifications, dealing mainly with the installation of the four-frequency nutating Cassegrain system. The 140-ft is expected to be returned to operation about mid-October.

Interferometer

		Hours
Scheduled Observing		1725.00
Scheduled Maintenance and Equipment Changes		210.00
Scheduled Tests and Calibration		273.00
Time Lost Due to:	Equipment Failure	60.50
	Power	2.50
	Weather	3.75
	Interference	2.00

The use of the 45-ft telescope is indicated in the program descriptions.

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

Observer	Program
D. Gibson (Virginia) F. Owen R. Hjellming	Observations to confirm the 6-cm 300-ft detection of NML Cygni.

Observer	Program
S. Goldstein (Virginia) R. Rood (Virginia) A. Marscher (Virginia)	Observations to develop techniques for deep source surveys.
D. Gibson (Virginia)	Investigation of variable radio emission in binary systems using the 45-ft telescope over a 35-km baseline.
D. Florkowski (Florida) S. Gottesman (Florida) F. Wood (Florida)	Examine four binary systems for radio emission.
G. Brandie (Queens, Canada) A. Bridle (Queens, Canada) B. Guindon (Queens, Canada) E. Fomalont	Comparison of the radio and optical orientation of elliptical radio galaxies.
P. Palmer (Chicago) R. Brown	Additional observations of radio emission from recent Type II supernovae.
D. Gibson (Virginia) R. Hjellming F. Owen	Observations, using the 45-ft telescope over a 35-km baseline, to confirm that as a class RS CVn binaries are radio emitters.
R. Hjellming R. Brown	Observations of Cyg X-3 in coordination with various observatories, using the 45-ft over a 35-km baseline.
P. Crane (MIT) R. Price (MIT)	Survey of 200 spiral galaxies using the 45-ft over a 35-km baseline.
J. Pipher (Rochester) M. Savedoff (Rochester) B. Soifer (U. California, San Diego)	Observations of compact HII regions.

The following line programs at 21-cm wavelength were conducted.

Observer	Program
E. Greisen	Aperture synthesis observations of neutral hydrogen absorption in W3, Ori A, W49 and W51.
B. Burke (MIT) P. Crane MIT)	High resolution observations of neutral hydrogen in NGC 1275, NGC 4051 and NGC 4151.

Observer	Program
S. Gottesman (Florida)	Study of the neutral hydrogen structure and kinematics of several types of galaxies.
J. Carlson (Maryland) F. Kerr (Maryland)	Observations, toward the galactic center to search for high velocity neutral hydrogen and hydrogen recombination lines, to find the existence of a massive black hole.
P. Baker (NASA-Greenbelt)	Observations of optically thick neutral hydrogen.

300-foot Telescope

	Hours
Scheduled Observing	1949.75
Scheduled Maintenance and Equipment Changes	158.50
Scheduled Tests and Calibration	99.75
Time Lost Due to: Equipment	14.00
Power	2.00
Weather	5.75
Interference	0.75

The following line programs were conducted during this quarter.

Observer	Program
G. Verschuur (Colorado)	Observations at 21-cm wavelength to map ridges of neutral hydrogen and two neutral hydrogen filaments.
R. Brown M. Roberts	Search between 500 and 1000 MHz for red-shifted 21-cm neutral hydrogen absorption lines in front of quasistellar objects.
J. Condon R. Brown D. De Young	Search, using line techniques, over the frequency range of 500-1000 MHz for evidence of radiation arising from coherent plasma interactions in compact radio sources.

The following continuum programs were conducted.

Observer	Program
J. Kapitzky (Massachusetts) W. Dent (Massachusetts)	Monitor at 2695 MHz the flux density and polarization of known variable extra-galactic sources and a continued search for other variable sources.

Observer	Program
F. Owen	Observations of Abell clusters of galaxies at 1400 MHz.
S. Anand (NASA-Greenbelt)	Radio maps at 1400 MHz around interacting and multiple galaxies.
W. Erickson (Maryland) J. R. Fisher	A 750-1000 MHz study of radio source variability coordinated with observations conducted at the Clarke Lake radio telescope.
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.
M. Kaftan-Kassim (SUNY-Albany) J. Sulentic (SUNY-Albany)	Observations of Markarian galaxies at 20-cm wavelength using a comparison control group of non-Markarian multiple systems.
D. Gibson (Virginia) R. Hjellming L. Blankenship	Monitor of Cyg X-3 at 610, 775 and 965 MHz for variability.
R. Price (MIT) P. Crane (MIT)	Observations of the continuum emission from spiral galaxies at 20-cm wavelength.

The following pulsar programs were conducted.

Observer	Program
R. Manchester (Massachusetts)	Pulsar timing and polarization measurements over the frequency range of 250-500 MHz.

36-foot Telescope	Hours
Total Time in Quarter	2208.00
Scheduled Observing Hours	870.50
Scheduled Maintenance and Equipment Changes*	1262.75
Scheduled Tests and Calibration	74.75
Time Lost Due to: Telescope	30.00
Receiver	23.00

*Includes summer shutdown

36-foot Telescope (continued)

		Hours
Time Lost Due to:	Digital Hardware	18.00
	Digital Software	4.50
	Weather	127.50
	Power	3.25
	Interference	0.00

Observer	Program
E. Conklin (NAIC) B. Ulich	Observations of unusual sources from the Ohio State Catalog.
R. Cornett (Maryland) G. Knapp (Caltech)	CO in supernova remnants.
R. Cornett (Maryland)	Investigation of CO emission associated with bright rims.
B. Ulich J. Payne J. M. Hollis	Telescope tests.
W. Dent (Massachusetts) R. Hobbs (NASA-Goddard)	Flux density variations of variable extragalactic radio sources.
S. Gottesman (Florida) A. Seacord (Florida)	CO survey of Cygnus X region of the galaxy.
R. Hjellming L. Blankenship R. Brown	Millimeter wavelength observations of Cygnus X-3 as part of international campaign.
F. Kerr (Maryland) W. Wilson (Aerospace Corp.) S. Simonson (Maryland)	Investigate CO shock fronts compared with HI observations.
G. Knapp (Caltech) R. Cornett (Maryland) F. Kerr (Maryland) W. Wilson (Aerospace Corp.)	Study CO density distribution and $C_{12}C_{13}$ ratio in dense interstellar clouds.
D. Ross J. Payne B. Ulich J. M. Hollis	Receiver testing of 80-120 GHz cooled Cassegrain receiver with nutating sub-reflector.

Observer	Program
M. Simon (SUNY, Stony Brook) R. Joyce (KPNO)	Observations of strong sub-millimeter sources and Markarian galaxies with strong IR content.
B. Turner P. Thaddeus (NASA Inst. for Space Studies)	Verification of N_2H^+ as the carrier of U93.174.
B. Ulich E. Conklin (NAIC)	Continuum observations of planetary satellites and asteroids.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

Green Bank Electronics

Manpower Assignments	Man Months	%
500-740 MHz Receiver	3	2.6
VLBI Effort	1	0.9
Interference Protection	3	2.6
256-channel Multifilter Receiver	1	0.9
Visitor Support & Maintenance	60	51.8
140-ft Cassegrain Receiver	15	12.9
VLA Support	10	8.6
Nutating Subreflector	7	6.0
Interferometer Remote Site Radio Link	4	3.4
New Receiver Development	3	2.6
140-ft Focus and Polarization Control	4	3.4
300-ft Computer Additions	3	2.6
140-foot Computer Additions	2	1.7
33 Full-Time, 1 Co-Op, 2 Temporary (2 mos.)	116	100.0

The 4-frequency Cassegrain front-end has been installed on the 140-ft telescope and integration with the telescope equipment is proceeding on schedule. First tests of the Cassegrain configuration are set for October 15-22.

The nutating subreflector for the 140-ft telescope has undergone extensive tests in a test stand. Nutating performance is as expected from the computer model. Switching rates to over 5 Hz with very good torque cancellation have been achieved.

Tucson Electronics

During the past quarter the 36-ft telescope was shut down for six weeks and the following pieces of new equipment were installed:

1. New Sterling mount servo system which permits the computer control of both focus and polarization.

2. A temperature monitor system that allows the temprature at many critical points to be monitored either by the computer or the operator. By measuring various temperatures around the dish under computer control the best focus may be computed and set without operator intervention.

3. A new azimuth bearing heater system. This system gives more adequate control than the old system and does not generate RFI.

4. A more reliable chopper wheel.

5. A new telescope servo system.

A new 9 mm prime focus receiver has been constructed that has approximately half the system temperature of the old system.

Measurements have been made on the 36-ft surface using a new technique. The results give surface accuracies that are in agreement with those predicted by RF measurements.

Tests on the 80-120 GHz receiver have continued, and this system is close to being an operational system. The remaining problems are some slight unexplained instabilities and a high noise temperature in the 80-90 GHz range.

ENGINEERING DIVISION

The 140-ft telescope Cassegrain installation continues to be the primary effort in the engineering division.

Other projects where engineering assistance was provided include preparation of the site on Spencer Ridge to receive the 45-ft antenna, preliminary studies and research on a proposed millimeter telescope, VLA transporter design, VLA site and buildings design, modifications to the 140-ft telescope service tower, and preliminary research in the possible use of a deformed subreflector on the 140-ft telescope.

Maintenance and operations were given engineering assistance as requested and required in Green Bank, Charlottesville and Tucson.

COMPUTER DIVISION

360 System - 512k bytes have been added to the system, bringing the total fast core memory to approximately 1-1/4 M bytes. The partition size available for a single job (small partition) has been increased from 90k to 106k bytes.

A second Tektronics graphics interactive terminal is now available for use by observers. Additional text terminals are also available.

The data rate on the line connecting the remote job entry system in Green Bank to the 360 system in Charlottesville has been increased (by a factor of three) to 7200 baud.

Interferometer - A new version of the standard interferometer program has been released for testing as a prelude to adopting it for a standard program package.

VERY LARGE ARRAY

Funding - Informal advice from NSF indicates that the full $13,000,000 requested was authorized and appropriated by the Congress, received from OMB and assigned to the Project by NSF. The Project received $3,500,000 in continuing resolution funds early in August, permitting some acceleration of the CY 1975 program.

Land Acquisition - Rancher Jack Bruton has signed a purchase agreement with the Corps of Engineers agreeing to sell a right-of-way over his land to the Government. This, with rights over State and Federal land, will permit the VLA to be constructed to the 13 kilometer point on the southwest arm; to the 6 kilometer point on the southeast arm; and to the 7 kilometer point on the north arm.

We now have archaeological approval to construct the array except for the last two kilometers on the southwest arm. Here artifacts showing the existence of a large archaic civilization have been discovered. For this section the New Mexico State University authorities have recommended an extensive excavation and cataloging operation estimated to cost in the vicinity of $60,000. As construction in this area is some years away, we are endeavoring to have this work financed through other funding by the NSF, the Interior Department or the State.

Electronics - Although some delivery problems have been encountered in this area, none are critical at this time. Design, fabrication and testing of electronics components is progressing well, with particular effort directed toward electronic modules associated with the front end unit. The initial test shipment of waveguide from Fujikura has been tested at Green Bank and accepted. Twelve hundred meters are enroute from Japan to the site. All feeds have been ordered.

Antennas - The subcontractor's final design for the antennas has been analyzed and accepted and fabrication of the first two antennas has been authorized, with delivery scheduled for spring 1975. NRAO engineers will continue to meet frequently with E-Systems personnel during fabrication.

Antenna Assembly Building - The design of the steel building and foundations was completed during August and accepted by NRAO. A subcontract was awarded for the building foundations and work began September 9, 1974.

Antenna Transporter - The final design for the transporter has been completed, analyzed and accepted and fabrication of the first transporter has been authorized. Procurement of hydraulic element components and equipment for the transporter is going well and orders have been placed for most items. Delivery of the first transporter is scheduled for March 1975.

Computer - Necessary modification of existing space has been completed and the synchronous computer was installed in the Ivy Road building. Personnel staffing in this area is nearly complete and the computer is being tested. The asynchronous computer has been ordered from Digital Equipment Corporation, using advance 1975 funding and is scheduled for delivery in December. Space for this larger computer has been obtained in a second building on Ivy Road, Charlottesville, and the necessary modifications begun. Staffing for the development of software for the asynchronous computer has begun.

Site and Wye - Phase II construction which includes the four permanent buildings, site utilities and power to the wye central area was completed and issued for bidding on September 3, 1974. Bids are expected in mid-October.

Take-up, shipment and receipt of the site of the 6.7 track miles of the Crab Orchard rail was completed at an overall cost of $62 per ton compared to the cost of delivery of new rail at $304 per ton. Efforts are underway to find and obtain additional sources of rail.

Construction bids were taken September 17 covering the construction of a 6000 square foot service building to house site staff and operations beginning in April 1975. Ten excellent bids were received ranging from $111,281 to $189,000. A contract covering the work was forwarded to the Foundation for approval on September 30.

Project Management - The VLA staff increased to 55 persons on September 30, including four part-time employees. Procurement actions continued during the quarter to obtain all components required for the 1974 fabrication and construction program. Major contracts let during this period were: Phase I site construction to Burn Construction Company, $605,000; synchronous computer to Modular Computer Systems, $248,616; and the asynchronous computer to Digital Equipment Corporation, $767,308.

Negotiations continued with the Socorro Electric Cooperative covering the construction of a special electric transmission line to the site, the construction of the site substation and the purchase of power.

An agreement has been reached with the New Mexico Institute of Mining and Technology at Socorro providing for the lease of 4800 square feet of existing space for VLA operations.

PERSONNEL

Appointments

John E. Miller	Telescope Engineer II	7/08/74
William E. Dumke	Electronic Engineer I	7/29/74
Robert W. Freund	Electronic Engineer I	8/05/74
R. Marcus Price	Associate Scientist	8/09/74
Gareth C. Hunt	Scient. Prog. Analyst II	8/11/74
Nancy R. Vandenburg	Mathematician	8/14/74
Thuppalay K. Menon	Visiting Scientist	8/14/74
Philip M. Dooley	Tech. Specialist I	8/15/74
Robert K. Moore	Business Manager - Green Bank Operations	8/26/74
Larry R. D'Addario	Research Associate	9/03/74
Robert G. Stidstone	Ant. Erection Engineer - VLA	9/04/74
Lawrence Rudnick	Research Associate	9/13/74
Lewis E. Somers	Applied Physicist	9/16/74
Ted J. McKenna	Systems Analyst	9/23/74

Terminations

David Buhl	Scientist	8/02/74
Carl Bignell	Research Associate	8/16/74
Alan deS. Parrish	Electronic Engineer I	9/20/74
Robert W. Haas	Electronic Engineer I	9/24/74

Leave of Absence

Michael Balister	Assoc. Division Head	9/13/74
Richard A. Sramek	Associate Scientist	9/15/74