

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

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RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE VA.

Quarterly Report

JUL 18 1977

April 1, 1977 - June 30, 1977

RESEARCH PROGRAMS

<u>140-Foot Telescope</u>	<u>Hours</u>
Scheduled observing	1385.25
Scheduled maintenance and equipment changes	705.50
Scheduled tests and calibration	74.50
Time lost due to: equipment failure	36.50
power	7.00
weather	0.00
interference	0.00

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
E. Chaisson (Center for Astrophys.)	Study at 4874 MHz the H110 α -recombination line in a few planetary nebulae.
N. Evans (Texas)	
M. Guelin (Inst. for Space Studies)	Observations of the 6-cm 110 α -recombination lines of hydrogen and carbon in NGC 1977.
S. Miller (Rensselaer)	
M. Kutner (Rensselaer)	
K. Tucker (Fordham)	
W. B. Burton	
H. Liszt	Observations to map the 6-cm H110 α -recombination line over the inner 2° of galactic longitude, and an attempt to confirm the detection of H110 α emission from NGC 253.
K. Fox (Tennessee)	
D. Jennings (Goddard)	Search at 4600 MHz for ¹² CH ₄ (methane) in Ori A, IRC+10216, and other molecular line sources.
P. Palmer (Chicago)	
L. Rickard	
B. Turner	Study of "quasi-thermal" and maser emission features of the 5-cm OH transitions.
P. Angerhofer (Maryland)	
G. Rossano (Maryland)	
T. Vestrand (Maryland)	Observations of the 110-111 transitions of HDCO at 5.35 GHz and H ₂ CO at 4.83 GHz.

<u>Observer</u>	<u>Program</u>
G. Knapp (Caltech) W. Sargent (Caltech) S. Faber (Calif., Santa Cruz) J. Gallagher (Minnesota)	Measurements of 21-cm hydrogen emission from nearby galaxies.
G. Knapp (Caltech) J. Gunn (Caltech) S. Tremaine (Caltech)	Observations of 21-cm hydrogen to measure the solar motion about the Galactic center and to study the outer distribution of hydrogen in the Galaxy.
M. Haynes (Indiana) M. Roberts	Search for 21-cm intergalactic hydrogen clouds near the galaxies NGC 55 and NGC 300; a study of the 21-cm hydrogen structure in the northernmost extension of the Magellanic Stream.
A. Rots (Netherlands Foundation for Radio Astronomy, The Netherlands) M. Haynes (Indiana) M. Roberts	Survey at 21-cm wavelength to determine the frequency of occurrence of HI satellites near galaxies.
F. J. Lockman (DTM)	Observations of 21-cm H166 α -recombination line emission to study the bulk motion in the ionized gas near the Rosette Nebula.
F. J. Lockman (DTM) R. L. Brown	Observations of 21-cm neutral hydrogen and the 21-cm H166 α -recombination line in the Cygnus-X region.
P. Seitzer (Virginia) F. Levinson (Virginia)	Study of 21-cm neutral hydrogen in galaxies associated with quasars.
L. Snyder (Illinois) F. Lovas (NBS) D. Johnson (NBS) L. Krisher (Maryland) D. Buhl (Goddard)	Observations at 6089 and 6176 MHz in an attempt to detect CH ₃ COOH (acetic acid).

The following continuum observations were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
A. Pacholczyk (Arizona) S. Goldstein (Virginia) M. Barnett (Virginia) D. Cioffi (Virginia)	High-accuracy measurements of the 5-cm integrated polarization of Cyg A and other selected sources.

<u>Observer</u>	<u>Program</u>
L. Rudnick H. Quintana	Search at 6-cm wavelength for the radio/ optical counterparts of high galactic latitude unidentified X-ray sources.

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

A - Algonquin, Canada 150-ft	F - Harvard Fort Davis 85-ft;
G - NRAO 140-ft;	I - Iowa NLRO 60-ft;
K - Haystack 120-ft;	N - NRL 85-ft; and
O - OVRO 130-ft.	

<u>Observer</u>	<u>Program</u>
K. Kellermann D. Shaffer	Observations at 18-cm wavelength to complete synthesis maps of several com- plex sources, to test for variations in these sources, and to search for other interesting sources. The stations used were F, O, and G.
J. Ball (Center for Astrophys.) J. Moran (Center for Astrophys.) M. Reid (Center for Astrophys.) K. Johnston (NRL)	Spectral-line observations at 18-cm to obtain absolute positions and to study the structure of OH masers. The stations used were F, G, and N.
J. Benson (Iowa) R. Mutel (Iowa)	Spectral-line observations at 18-cm of the OH/IR sources VY Canis Majoris and NML Cygnus. The stations used were G, I, K, and N.
J. Moran (Center for Astrophys.) M. Reid (Center for Astrophys.) K. Johnston (NRL) J. Yen (Toronto, Canada)	Observations to map the 5-cm OH line spatial structure in a number of maser sources using the stations A, G, and N.
M. Cohen (Caltech) A. Moffet (Caltech) G. Seilestad (Caltech) J. Romney (Caltech) R. Linfield (Caltech) A. Readhead (Caltech)	Observations at 6-cm wavelength to monitor selected sources, using the stations F, O, and G.
B. Geldzahler (Pennsylvania) K. Kellermann D. Shaffer	Observations of the Galactic center at 8.4 GHz, using the Haystack 120-ft telescope and the NRAO 140-ft telescope.

<u>Observer</u>	<u>Program</u>
T. Clark (Goddard)	Observations at 8.4 GHz to measure the positions of and study the small-scale kinematics of the nuclei of various types of radio sources, to improve and validate the geodetic capabilities of VLB techniques, and to validate new VLB instrumentation and techniques using telescopes at G, K, and O.
R. Coates (Goddard)	
L. Hutton (Goddard)	
J. Ryan (Goddard)	
D. Robertson (Nat. Geodetic Survey)	
C. Counselman (MIT)	
J. Wittels (MIT)	
I. Shapiro (MIT)	
C. Ma (Maryland)	
H. Hinteregger (Haystack)	
C. Knight (Haystack)	
A. Rogers (Haystack)	
A. Whitney (Haystack)	
J. Moran (Center for Astrophys.)	
G. Resch (JPL)	

<u>Interferometer</u>	<u>Hours</u>
Scheduled observing	1829.75
Scheduled maintenance and equipment changes	136.00
Scheduled tests and calibration	163.25
Time lost due to: equipment failure	38.75
power	0.00
weather	4.75
interference	0.25

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

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

<u>Observer</u>	<u>Program</u>
K. Lang (Tufts)	Study of small-scale magnetic field structures in active solar regions, using the 45-ft telescope.
J. Burns (Indiana)	Detailed mapping of selected head-tail radio sources, using the 45-ft telescope.
F. Owen	
L. Rudnick	
E. Seaquist (Toronto, Canada)	Maps of radio emission from normal spiral galaxies, using the 45-ft telescope.
P. Crane	

<u>Observer</u>	<u>Program</u>
R. M. Price (NSF) P. Crane	Monitor flux density variations of compact sources in spiral galaxies, using the 45-ft telescope; observations to complete a survey of emission from normal galaxies.
P. Gregory (British Columbia, Canada) E. Seaquist (Toronto, Canada)	An attempt to confirm the radio detection of a number of emission line stars, using the 45-ft telescope.
F. Ghigo (Brandeis)	Measurements of the angular structure of radio sources associated with optical jets, using the 45-foot telescope.
D. Altschuler (Maryland) J. Wardle (Brandeis)	Monitor the variability of flux and polarization in approximately 80 sources.
H. Johnson (Lockheed)	Study of radio sources in globular clusters, some of which are X-ray sources; of strong X-ray sources near the Galactic center; and observations to monitor so-called X-ray bursts coordinated in part with satellite observations.
R. Spencer (Jodrell Bank, England) W. Saslaw (Virginia) R. Porcas	Observations to obtain high-resolution maps of 3C 265.
W. Altenhoff (MPIR, Bonn, W. Germany) J. Wink (MPIR, Bonn, W. Germany)	Observations of HII regions whose diameters are less than 2 arc minutes.
K. Johnston (NRL) C. Wade F. Owen	An attempt to measure the absolute position, parallax, and proper motion of four binaries, using the 45-ft telescope.
T. K. Menon (Tata Inst., India)	An attempt to detect compact components in a selected sample of Ooty sources.
J. Beall (Maryland)	Observations of NGC 4151 in coordination with X-ray and IR studies.
W. Cotton (MIT) S. Spangler	Observations to monitor the variability at high frequencies of extragalactic radio sources that are known variables or probable variables at 365 MHz.

<u>Observer</u>	<u>Program</u>
D. Backer (Berkeley) R. Sramek (NAIC, Puerto Rico)	Proper motion and parallax studies of pulsars and radio stars, using the 45-ft telescope.
B. Geldzahler (Pennsylvania)	Attempt to detect three recent novae.
P. Kronberg (MPIR, Bonn, W. Germany) M. Normandin (Toronto, Canada)	Linear polarization observations of QSO's and radio galaxies with measured redshift.
P. Feldman (York, Canada) C. Purton (York, Canada) E. Seaquist (Toronto, Canada)	Study of the radio star HM Sag.

<u>300-Foot Telescope</u>	<u>Hours</u>
Scheduled observing	2023.75
Scheduled maintenance and equipment changes	150.50
Scheduled tests and calibration	0.00
Time lost due to: equipment failure	14.50
power	7.50
weather	1.00
interference	0.00

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
F. Owen	Search at 930 MHz for highly redshifted 21-cm hydrogen absorption in a source which has purely absorption redshift at optical wavelengths.
T. Thuan (Virginia) S. Goldstein (Virginia)	Search for 21-cm intergalactic hydrogen in the vicinity of nearby galaxies.
T. Cram E. Greisen	Observations at 21-cm wavelength of selected high-velocity hydrogen clouds.
T. Thuan (Virginia) G. Knapp (Caltech)	Measurements of 21-cm hydrogen redshifts in so-called "single galaxies".
G. Steigman (Yale) T. Cram	Observations of 21-cm hydrogen toward bright stars.

<u>Observer</u>	<u>Program</u>
G. Knapp (Caltech) W. Sargent (Caltech)	Measurements of 21-cm hydrogen redshifts in groups of galaxies in the local supercluster.
A. Haschick (MIT) W. Baan (MIT) P. Greenfield (MIT) B. Burke (MIT)	Search for 21-cm redshifted hydrogen absorption in a complete sample of radio galaxies.
D. Cioffi (Virginia) F. Levinson (Virginia)	Search for 21-cm hydrogen absorption from dark nebulae and Bok globules.
A. Marscher (Virginia) R. Brown	Search between frequencies of 740 and 1000 MHz for highly redshifted 21-cm hydrogen absorption in quasars.
B. Peterson (Arizona)	Observations of 21-cm redshifted hydrogen absorption in QSO's and BL Lac objects found in Abell clusters.
A. Haschick (MIT) P. Crane	Study of the variability of 21-cm hydrogen absorption in 3C 84.
P. Crane	Study of 21-cm hydrogen in a complete sample of spiral galaxies.

The following continuum programs were conducted.

<u>Observer</u>	<u>Program</u>
W. Jaffe (Inst. for Advanced Study) L. Rudnick	Study extended emission in clusters of galaxies at 610 MHz.
W. Dent (Massachusetts) T. Balonek (Massachusetts) M. Hartman (Massachusetts)	Study of the 2695 MHz polarization and flux density of known extragalactic radio sources.
J. Burns (Indiana) F. Owen	Observations of Zwicky clusters of galaxies at 2695 MHz.
W. Cotton (MIT) S. Spangler	Observations at four discrete frequencies between 270 and 435 MHz and at 1400 MHz to monitor variable sources selected from the U. Texas interferometer survey.

<u>Observer</u>	<u>Program</u>
L. Rickard	Attempt at 6-cm wavelength to detect continuum emission from compact clusters of compact galaxies.
D. Shaffer	Observations at 6-cm wavelength to check for variability of a subset of weak sources selected from the M. M. Davis 300-ft 6-cm survey.
S. Spangler	Scintillation total power and polarization measurements of radio sources at 1400 MHz.
M. Gearhart (Ohio State)	Flux density measurements at 740 and 990 MHz of selected Ohio State sources.
E. Pacht (Ohio State)	
J. Kraus (Ohio State)	

The following pulsar program was conducted.

<u>Observer</u>	<u>Program</u>
R. Hulse	Search at 410 MHz for new, high-latitude pulsars.

<u>36-Foot Telescope</u>	<u>Hours</u>
Scheduled observing	1972.25
Scheduled maintenance and equipment changes	157.00
Scheduled tests and calibration	54.75
Time lost due to: equipment failure	38.25
weather	39.50
power	7.75
interference	0.00

<u>Observer</u>	<u>Program</u>
L. Avery (Herzberg Inst. of Astrophys.)	Search for interstellar magnesium oxide.
A. Douglas (Herzberg Inst. of Astrophys.)	
N. Broten (Herzberg Inst. of Astrophys.)	
J. MacLeod (Herzberg Inst. of Astrophys.)	
D. Blake (Chicago)	Study of deuterated ammonia in selected sources.
P. Palmer (Chicago)	
J. Davis (Texas)	Search for the C ₂ O radical.
H. Pickett (Texas)	

<u>Observer</u>	<u>Program</u>
W. Dent (Massachusetts) R. Hobbs (Goddard)	Evolution of extragalactic radio sources at millimeter wavelengths.
D. Dickinson (Harvard) M. Reid (Harvard)	Radial velocities of long-period variability using SiO emission.
D. Heesch	9-mm and 3-mm observations of elliptical galaxies with flat spectra.
L. Higgs (Herzberg Inst. of Astrophys.) P. Feldman (Herzberg Inst. of Astrophys.) J. Smolinski (Nicolaus Copernicus Univ., Torun, Poland)	Measurement of 3-mm flux of HD217476, a radio emitting supergiant.
R. Hobbs (Goddard) L. Brown (Goddard) S. Maran (Goddard) D. Buhl (Goddard) T. Clark (Goddard) S. Mosier (Goddard)	Observations at 3 mm of polarization of discrete sources.
R. Hobbs (Goddard) R. Sinha (Maryland) F. Kerr (Maryland)	Map of the Galactic center at 90 GHz.
K. Kellermann B. Geldzahler (Pennsylvania) I. Pauliny-Toth (MPIR, Bonn, W. Germany) A. Witzel (MPIR, Bonn, W. Germany)	Observations at 9 mm of flat spectrum sources in the NRAO-Bonn survey.
G. Knapp (Caltech) M. Morris (Caltech)	Search for high-velocity CO emission in the direction of W49 and W51.
H. Liszt W. B. Burton	Study of CO distribution in the inner portion of the galaxy.
S. Maran (Goddard) R. Hobbs (Goddard) M. Jura (Calif., Los Angeles)	Continuum observations of NGC 1068 at 90 GHz.
M. Morris (Caltech) A. Alcock (Caltech)	Attempt to detect thermal emission of SiO in stellar sources.

<u>Observer</u>	<u>Program</u>
P. Palmer (Chicago) M. Morris (Caltech) B. Zuckerman (Maryland) B. Turner D. Gilra (Groningen, Netherlands)	Study of shells in cool, evolved stars.
R. Partridge (Haverford) G. Lake (Princeton)	Search for the Sunyaev-Zel'dovich effect at 9 mm.
C. Purton (York, Canada) P. Feldman (Herzberg Inst. of Astrophys.)	Search for continuum emission from stars with circumstellar envelopes.
L. Rickard B. Turner P. Palmer (Chicago) M. Morris (Caltech) B. Zuckerman (Maryland)	Maps of galaxies in CO and observations of CO isotopes.
P. Solomon (SUNY, Stony Brook) N. Scoville (Massachusetts) D. Sanders (SUNY, Stony Brook)	Distribution of CO emission in galactic latitude.
L. Snyder (Illinois) J. Hollis D. Buhl (Goddard) W. Watson (Illinois)	Study of deuterated species DCO+, DCN, and DNC.
L. Snyder (Illinois) L. Brown (Goddard) D. Buhl (Goddard) D. Dickinson (Harvard)	Study of SiO masers in young stars.
P. Thaddeus (Inst. for Space Studies) M. Guélin (Inst. for Space Studies)	Confirmation of a new nonterrestrial molecule H ₂ CN.
L. Weliachew (Observatoire de Paris, France) P. Encrenaz (Observatoire de Paris, France) R. Lucas (Observatoire de Paris, France) F. Combes (Observatoire de Paris, France)	Maps of CO emission in the spiral arms of M31 and M81.

<u>Observer</u>	<u>Program</u>
W. Wilson (Texas)	CO absorption in the atmospheres of
S. Gulkis (JPL)	Mars and Venus and the search for CS,
R. Kakar (JPL)	SO ₂ , SO and OCS in planetary atmos-
M. Klein (JPL)	pheres.

ELECTRONICS DIVISION

Charlottesville

The VLB Mark III system development is progressing, and a request is being submitted to schedule an experiment between Green Bank and Haystack during September 1977. Six video channels (twelve recorder tracks) should be available for this experiment. NRAO has recently received the Honeywell 28-track head and is expecting delivery of a Spin Physics 28-track head in July.

Development of Model IV autocorrelator has run into a problem resulting from a National Semiconductor decision to withdraw their Super Pace Computer from the market. A Varian V77-400 computer has been ordered as a replacement and is due to be delivered in August 1977. This will result in some delay; it is now expected that the correlator will be ready for observing during November 1978.

During this quarter NRAO has built several 2-mm mixer mounts similar to the A. R. Kerr (NASA) design. These have to be whiskered and will be used in the new Tucson 2-mm (130-170 GHz) receiver.

Progress on the 1-mm (230 GHz) mixer has been delayed by other projects. However, we expect to complete the mixer and make measurements in the near future.

Green Bank

The 140-foot telescope was out of operation most of the month of May for the installation of a ModComp II computer for on-line data handling. This computer is now interfaced to all of the 140-foot observing equipment and is in full operation. During this shutdown reflection tests were made from the prime focus at 9 cm to study the spectral-line baseline ripple problem. All of the major reflections were identified and some corrective modifications to the telescope are being designed.

The first 18-25 GHz maser built in Green Bank became operational in May. Considerable improvements have been made to the bandpass shape near the ends of the tuning range, and further development continued. Members of the Tucson

electronics staff arrived in Green Bank at the end of June to begin integrating this maser into a downconverter system for Kitt Peak. A frequency/phase locked LO system has been developed for the 140-foot maser system which can frequency switch over 500 MHz in less than 10 milliseconds.

An inexpensive servo motor for the 140-foot deformable subreflector has been acquired and tested. An on-line VLB data quality analyzer has been built and tested. Cooled FET amplifiers and different feed designs are being investigated in an effort to improve the low-frequency receivers.

Tucson

During this quarter the PDP 11 computer was delivered and installed in the downtown laboratory. A 256-channel integrator/multiplexer has been completed and interfaced to the computer. This has been tested, and the multiplexer may now be used to troubleshoot filter banks downtown.

All the equipment necessary for the whiskering of diodes has been acquired, and during the next few months we hope to be able to relieve Charlottesville of this task.

Work is continuing on the 130-170 GHz receiver, and we expect to complete this by the end of the year.

Work has started on the varactor down-converter system using the 18-26 GHz maser as an IF amplifier. A prototype LO injection system has been designed and will be completed in the next few weeks along with the modified dewar vessels and radiation shields. We hope to have the system working in the laboratory before the end of the year with receiver temperatures of around 100° K at 115 GHz.

ENGINEERING DIVISION

Design and field supervision continued for modifications and additions to equipment and structure on the 140-foot telescope. Drawings and specifications for the deformable subreflector and mounting frame for the 140-foot were completed and orders were placed for their fabrication. Design and research continued on a deforming system. Research and conceptual design continued for a future 25-m millimeter wavelength telescope and astrodome. Design was completed and fabrication started for modifications and additions to the 36-foot telescope. Assistance was provided in the research and development of a surface measuring instrument. Inspection assistance was provided the VLA project. Routine engineering assistance was provided operations and maintenance at Charlottesville, Green Bank, and Tucson.

COMPUTER DIVISION

140-foot Telescope

Control System - The 140-foot control computer has been installed, replacing the original Honeywell DDP116. The physical separation of the telescope control and off-line data analysis function has been kept. The new control system is implemented in FORTRAN running under the manufacturer's operating system and enables the telescope operator to define and automate fairly complex control procedures. Flexible automated card control of the telescope is now possible; observing efficiency has been significantly increased.

Manuals describing the system in some detail are in preparation.

Off-Line Data Analysis Manual - A manual describing the use of the 140-foot off-line Modcomp TPOWER/SPOWER system is available. The manual "On-Site Spectral Line Data Reduction" by Kathy L. Harper and Thomas R. Cram may be obtained by writing the Computer Division secretary and requesting NRAO Users Manual Report No. 28.

VLBI

The on-line program has been modified to allow processing of data recorded with only one head.

Processor hardware and software are undergoing modification to allow the use of additional information recorded at the time of observation, such as system temperature, source name, and a "good data" flag.

VLA Post-Processing

A set of programs has been developed which process VLA data, starting with calibrated output from the DEC-10 system. With the exception of calibration operations, the programs provide capabilities similar to those of the older Green Bank interferometer package.

VERY LARGE ARRAY PROGRAM

Antenna No. 10 was accepted on April 22, 1977, Antenna No. 11 accepted June 9, 1977, and Antenna No. 12 was undergoing acceptance tests the last of June, 1977. Fringes were obtained with Antenna No. 7 on May 10 and with Antenna No. 8 on June 23, 1977.

During the observing run on May 22-25, the fixed head disk between the synchronous and asynchronous computers and the real time filler program were activated, providing direct communication between the two computers.

Most of the electronic design modifications which were required to bring the performance of the prototype system within specifications have now been completed. The prototype batch of the VLA-2 custom integrated circuits was under test and the preliminary results have been very satisfactory.

Approximately 850 hours were scheduled for tests, calibrations, and observations with arrays of up to seven antennas. The sixteen observing programs run mainly involved studies of point sources, and were chosen primarily to provide measurements of the instrumental characteristics.

PERSONNEL

Appointments

Walter J. Jaffe	Assistant Scientist	6/01/77
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Terminations

Mikio Ogai	Electronics Engineer I	6/24/77
Russell A. Hulse	Research Associate	6/24/77
Ralph E. Spencer	Vis. Associate Scientist	6/28/77
Richard W. Porcas	Research Associate	6/30/77
George H. Conant	Scient. Prog. Analyst I	6/30/77

Changes in Status

Robert L. Brown	Asst. Director GB/Scientist	6/01/77
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SUMMER STUDENT PROGRAM

In November 1976, more than 125 colleges and universities received announcements of our 1977 summer student program. From the more than 150 applications received, 21 students were selected to participate in the program as research assistants to the scientific staff and in the electronics and computer divisions. Eleven students are working in Charlottesville, six in Green Bank, and four in Socorro.

Lectures, 22 in number, will be given by the staff on various topics in radio astronomy and instrumentation. Students are encouraged to attend the regular NRAO colloquia and seminars. They will also assist as tour guides in the public education program in Green Bank.

Since its beginning in 1959, 444 students have participated in the summer program. We have had several students return as thesis students, and some have returned as full-time employees.

The names of the 1977 students, their academic year and school are given below.

Name	Academic Year	School
Adams, Mark T.	G-1	U. Arizona
Ajith-Kumar, K.	G-1	Stanford
Bothun, Greg	G-1	U. Washington
Cioffi, Denis F.	G-1	U. Virginia
Cooper, Robert C.	U-4	Rice
Ghosh, Sanjoy	U-4	Ohio State
Hartke, Gregory J.	U-4	Loyola
Klein, Andrew V.	G-2	U. Chicago
Krishnaswamy, Sumant	G-2	Maryland
Meyers, Karie A.	G-1	Pennsylvania State
Moore, Richard L.	G-1	U. Arizona
McGlynn, Thomas A.	U-4	Haverford
Neff, Susan G.	G-1	Indiana
Petti, Paula L.	U-4	Brandeis
Predan, Vitja		Chalmers (Sweden)
Reitan, Ronald C.	G-1	U. Minnesota
Rodgers, Todd K.	U-4	Johns Hopkins
Sayre, David E.	U-4	U. Michigan
Spencer, Richard W.	U-4	U. California, Berkeley
Vestrand, W. Thomas	G-2	U. Maryland
Virmani, Ashutosh	G-1	Lehigh

OBSERVATORY COLLOQUIA

The twenty-four speakers in the NRAO colloquium program for the year ending June 30, 1977, are outlined below. The speakers are usually invited by the scientific staff, and talk on topics of current interest in radio astronomy or closely allied fields. The Astronomy Department of the University of Virginia also invites speakers to their own colloquium series. These series are jointly announced and well attended by our staff, university physicists and astronomers, and students.

<u>Name</u>	<u>Institution</u>
T. M. Bania	Arecibo Observatory
R. Bates*	CSIRO, Australia
J. J. Broderick	Virginia Polytechnic Institute & State University
J. A. Earl	University of Maryland
R. Giovanelli	University of Bologna, Italy
K. J. Johnston	U. S. Naval Research Laboratory
G. R. Knapp	California Institute of Technology
J. Milne	CSIRO, Australia
H. Olthof	Max-Planck-Institut fur Extraterrestrial Physik
B. J. Rickett	University of California, San Diego

* VLA Site, Socorro

<u>Name</u>	<u>Institution</u>
W. K. Rose	University of Maryland
R. Sancisi	University of Groningen, Netherlands
W. W. Shane	Sterrewacht, Leiden
M. Shapiro	U. S. Naval Research Laboratory
G. A. Shields	University of Texas
W. A. Stein	University of Minnesota
P. Thaddeus	Institute for Space Studies
S. Tsuruta	Max-Planck-Institut fur Astrophysik and Montana State University
S. H. Wang	Peking Observatory
W. D. Watson	University of Illinois
H. F. Weaver	University of California, Berkeley
D. W. Weedman	Vanderbilt University
S. J. Wernecke	Stanford University
A. S. Wilson	University of Sussex, England