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NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report

April 1 - June 30, 1971

RESEARCH PROGRAMS

<u>Interferometer</u>	<u>Hours</u>
Scheduled observing	1678.25
Scheduled maintenance and equipment changes	485.75
Time lost due to: equipment failure	29.25
power	0.25
weather	4.25
interference	7.25

During this quarter, the following continuum observations at 2695 and 8085 MHz were conducted simultaneously, except as noted.

<u>Observer</u>	<u>Program</u>
R. Hjellming and C. Wade	Observations of intensity and structural time changes of Sco X-1, in coordination with data taken by the Uhuru X-ray satellite, balloon X-ray flights, and optical observations at Cerro Tololo, Chile.
W. Webster (NASA-Goddard), W. Altenhoff (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany), J. Wink (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany, and P. Mezger (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany)	Observations of condensations in H II regions.
P. Palmer (Chicago), S. Gottesman, J. Broderick, and R. Brown	Observations in an attempt to detect emission from recent extragalactic supernovae.
R. Sramek	Observations of the structure of radio cores in normal elliptical galaxies, utilizing 85-1, 85-2, and 85-3 at 2695 MHz and 8085 MHz, and the 42-foot portable telescope with 85-1 and 85-2 at 2695 MHz.

ObserverProgram

W. Webster (NASA-Goddard), W. Altenhoff (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany), J. Wink (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany), P. Mezger (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany), and R. Hjellming

Observations of the accurate size, flux density, position and polarization of a number of small diameter, high flux density sources in Altenhoff's 11-cm survey.

E. Fomalont and K. Kellermann

Survey of radio sources at 2695 MHz whose flux densities range from 0.001 to 0.01 flux units.

B. Balick (Cornell)

Observations at 2695 MHz, utilizing the 42-foot telescope, of condensations in H II regions, specifically in DR 21, W 51, W 33, and IC 410.

E. Fomalont

Observations at 2695 MHz of linear polarization fine structure of extended extragalactic sources using 85-1, 85-2, and the 42-foot portable telescope at the Spencer's Ridge site.

R. Hjellming and C. Wade

Observations of intensity and structural changes of X-ray sources and of stellar radio emission from the following objects: magnetic white dwarfs, UV Ceti stars, other magnetic stars, shell stars, and red giants and supergiants whose emission may vary with time.

B. Burke (M.I.T.) and J. Spencer (M.I.T.)

Observations of emission from H II regions in the external galaxies M 31 and M 33.

K. Johnson (Arizona) and K. Kellermann

Observations of flux densities of variable sources.

R. Hjellming, C. Wade, and V. Herrero

Study of intensity versus time of two recent novae.

R. Huguenin (Massachusetts), J. Taylor (Massachusetts), R. Hjellming, and C. Wade

Search for variations in pulsar intensity during the pulsar "off" time.

W. Webster (NASA-Goddard), G. Webster (Sperry Management Systems), and A. Webster (Monmouth College)

Observations of the planets Uranus and Neptune, and an attempt to detect the planet Pluto.

<u>Observer</u>	<u>Program</u>
W. Burton	Studies of the Faraday rotation from a number of sources surrounding M 33, M 51, and M 101.
D. Hogg and D. De Young	Search for intensity time variations in the complex sources Vir A, Cyg A, and Cas A.

The NRAO autocorrelator Model III and 21-cm front ends were installed on the three 85-foot telescopes and tested. The following neutral hydrogen programs were conducted.

<u>Observer</u>	<u>Program</u>
B. Clark	Search for circumstellar neutral hydrogen envelopes.
K. Riegel	Optical depth measurements of cold neutral hydrogen in front of galactic continuum sources in the longitude range 30 to 352 degrees.

<u>140-foot Telescope</u>	<u>Hours</u>
Scheduled observing	1931.25
Scheduled maintenance and equipment changes	252.75
Time lost due to: equipment failure	31.00
power	1.25
weather	13.50
interference	0.25

The following line observations were conducted.

<u>Observer</u>	<u>Program</u>
T. Wilson (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany) and W. Altenhoff (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany)	Recombination-line observations of the Rosette Nebula at 6-cm wavelength.
T. Wilson (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany)	An attempt to observe recombination lines at 6 cm in the radio source G45.5+0.1.
C. Gottlieb (Harvard), J. Ball (Harvard), H. Radford (Smithsonian), and B. Zuckerman (Maryland)	Observations at 4917 MHz to confirm the detection of CH ₂ O ₂ (formic acid).

ObserverProgram

C. Gottlieb (Harvard), J. Ball (Harvard),
A. Lilley (Harvard), and H. Radford
(Smithsonian)

A search for CH_3OH (methyl alcohol) at
5005 MHz in the strongest formaldehyde
sources and simultaneous observations of
 $\text{H}138\beta$ at 4898 MHz to allow interpretation
of the CH_3OH profile which is confused
by $\text{H}137\beta$.

G. Verschuur

Observations at 4830 MHz in an attempt to
detect H_2CO (formaldehyde) in high lati-
tude and high velocity hydrogen clouds,
and to determine interstellar cloud tem-
peratures from observations of the for-
maldehyde line.

P. Solomon (Columbia), P. Thaddeus
(Goddard Institute for Space Studies),
and N. Scoville (Columbia)

Observations at 4830 MHz to expand the
galactic center map in H_2CO (formaldehyde)
and to explore several dark clouds in the
galaxy for formaldehyde, and observations
at 4602 MHz to search for $\text{C}_3\text{H}_4\text{N}_2$ (imida-
zole).

P. Solomon (Columbia), P. Thaddeus
(Goddard Institute for Space Studies),
and R. de Zafra (Goddard Institute for
Space Studies)

A search for the ring molecule $\text{C}_4\text{H}_4\text{O}$
(furan) at 4575.7 MHz.

M. Gordon and M. Roberts

Low angular resolution pilot survey of
galactic H_2CO (formaldehyde) at 4830 MHz.

T. Wilson (Max-Planck-Institut für
Radioastronomie, Bonn, W. Germany)

Observations at 4830 MHz to search for
 H_2CO (formaldehyde) in Bok globules,
measure the linear size in formaldehyde
of W 40 and W 48, and measure formalde-
hyde in absorption near several strong
isolated radio sources.

Y. Minn (Rensselaer) and J. Greenberg
(State U. of New York, Albany)

Observations at 6 cm of H_2CO (formaldehyde)
to study dust clouds and galactic structure.

L. Snyder (Virginia) and F. Clark
(Virginia)

Search at 6 cm for H_2CO (formaldehyde)
at the interface between late-type stars
and dust clouds.

Y. Terzian (Cornell) and B. Balick
(Cornell)

Search at 3 cm for the $\text{H}85\alpha$ recombination
line in planetary nebulae.

<u>Observer</u>	<u>Program</u>
W. Flygare (Illinois), R. Benson (Illinois), H. Tigelaar (Illinois), R. Rubin (Illinois) and T. Willis (Illinois)	A search for the following molecules: HCOCH ₂ OH (glycolaldehyde) at 10.927 GHz, CH ₂ CHCN (vinyl isocyanide) at 10.256 GHz, and HNCO (isocyanic acid) at 160 MHz.
A. Barrett (M.I.T.) and P. Myers (M.I.T.)	Observations at 6 cm to map four galactic clouds in H ₂ CO (formaldehyde).
B. Turner	Observations at discrete frequencies in the range 8 to 9.5 GHz in a search for the following molecules: C ₂ H ₅ OH (ethyl alcohol), HC ₃ HO (propynal), CH ₂ (CH) ₂ (cyclobutene), S(CN) ₂ (sulphur dicyanide), and (CH ₂) ₃ CO (cyclobutanone).
D. Cesarsky (Harvard), J. Ball (Harvard), A. Dupree (Harvard), L. Goldberg (Harvard), and A. Lilley (Harvard)	Observations at 880 MHz of the 195 α transition of hydrogen, helium and carbon.
C. Gottlieb (Harvard), J. Ball (Harvard), A. Lilley (Harvard), H. Radford (Smithsonian)	Search for CH ₃ NH ₂ (methyl amine) at 880 MHz.
P. Palmer (Chicago), C. Gottlieb (Harvard), and B. Zuckerman (Maryland)	Search for H ₃ SiCCH at 9.657 GHz.
P. Palmer (Chicago), B. Zuckerman (Maryland), C. Gottlieb (Harvard), and J. Yen (U. of Toronto, Canada)	Additional studies of the $^2\pi_{3/2}, J = 5/2$ state of OH at 6 GHz, particularly in NGC 6334 N.
D. Dickinson (Harvard)	A search at 6.031 and 6.035 GHz for the $^2\pi_{3/2}, J = 5/2$ of OH in Sgr A and the supernova remnants W 28, W 44, and W 81.
B. Zuckerman (Maryland) and P. Palmer (Chicago)	A search for the $2_{02}-1_{01}$ transition of C ₆ H ₅ CN (benzonitrile) at 5.522 GHz, for C ₇ H ₈ (toluene) at 8.410 GHz, for C ₄ H ₆ O (crotonaldehyde) at 8.513 MHz, and for C ₂ H ₄ O (acetaldehyde) at 8.243 GHz.
R. Rubin (Illinois), W. Flygare (Illinois), R. Benson (Illinois), T. Willis (Illinois), and B. Turner	Observations to confirm the detection of interstellar (CH ₃) ₂ CO (acetone) at 10.74 GHz.

The following continuum observations, except very long baseline programs, were conducted.

<u>Observer</u>	<u>Program</u>
W. Altenhoff (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany)	Observations at 6 cm of the Rosette Nebula.
M. Kundu (Maryland)	Observations to study the intensity and polarization of the Cygnus Loop and to search for polarized emission in several supernova remnants at 6 cm.

The following very long baseline observations were conducted.

<u>Observer</u>	<u>Program</u>
L. Matveyenko (Cosmic Space Institute, Moscow, USSR), I. Moiseev (Crimean Astrophysical Observatory, USSR), L. Shatrovsky (Cosmic Space Institute, Moscow, USSR), V. Efanov (Crimean Astrophysical Observatory, USSR), M. Cohen (Calif. Inst. of Tech.), D. Shaffer (Calif. Inst. of Tech.), D. Jauncey (Calif. Inst. of Tech.), B. Clark, K. Kellermann, and J. Broderick	Observations at 8.429 GHz of small-scale structure of radio galaxies and quasars using the Crimean 22 meter telescope, the NASA Goldstone 210-foot telescope, and the 140-foot telescope.
G. Purcell (Calif. Inst. of Tech.) and D. Shaffer (Calif. Inst. of Tech.)	Observations at 606 MHz of the size and structure of radio sources having substantial structure between 0.1 and 0.01 arc seconds, using the Calif. Inst. of Tech. Owens Valley 130-foot telescope and the NRAO 140-foot telescope.

<u>300-foot Telescope</u>	<u>Hours</u>
Scheduled observing	1763.75
Scheduled maintenance and equipment changes	420.25
Time lost due to: equipment failure	83.00
power	0.00
weather	0.25
interference	2.50

During this quarter the following continuum observations were conducted.

<u>Observer</u>	<u>Program</u>
W. Saslaw (Virginia)	Observations of the radio properties of Haro galaxies at 20-cm wavelength.
C. Purton (York University, Toronto, Canada) and J.E.D. Kennedy (York University, Toronto, Canada)	Observations at 20 cm of the structures of approximately 50 faint, extended galactic sources, pairs of interacting

<u>Observer</u>	<u>Program</u>
C. Purton, <u>et als.</u> , continued	galaxies which might display unusual radio properties, and flux density of 3C 318.1, for which little information exists above 960 MHz, and of 3C 326.1 to test for variability.
D. Jauncey (Cornell)	Observations at 20 cm of the confusion background level of radio sources.
H. Murdoch (U. of Sydney, Australia)	Observations at 20 cm of the spectra of weak sources.
I. Pauliny-Toth (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany), K. Kellermann, and M. Davis	Flux densities at 20 cm of sources recently studied in a 6-cm survey.
M. Kundu (Maryland) and T. Velusamy (Maryland)	Observations at 20 cm in a search for weak extended sources in the direction of pulsars having long periods.
T. Menon (Tata Institute, Bombay, India)	Measurements of 20-cm fluxes of 350 sources for which occultation positions are available from the Indian occultation telescope.
G. Westerhout (Maryland)	Observations at 20 cm of the polarization of the galactic background.

The following line observations were conducted.

<u>Observer</u>	<u>Program</u>
S. Gottesman	Neutral hydrogen, 21-cm studies of spiral arms in extragalactic systems and of the Cyg X complex.
M. Wright	Neutral hydrogen 21-cm study of the edges of known and possible extragalactic objects.
M. Roberts	Observations at 21 cm of neutral hydrogen in galaxies.
G. Verschuur	High-resolution studies of 21-cm neutral hydrogen at high galactic latitudes.
G. Grasdalen (Berkeley), C. Heiles (Berkeley), and B. Turner	Survey at 18 cm of a sample of IR stars for OH emission at all four ground-state frequencies.

<u>Observer</u>	<u>Program</u>
S. Gottesman and M. Wright	Observations at 1665 MHz and 1667 MHz of OH absorption in galaxies that are radio sources, and of OH emission from high velocity clouds.
R. Harten (Maryland) and G. Mader (Maryland)	Observations of galactic 21-cm neutral hydrogen to compare and to aid in combining data taken in the northern and southern hemispheres.
G. Westerhout (Maryland), S. Simonson (Maryland), R. Harten (Maryland), and G. Mader (Maryland)	Observations of 21-cm neutral hydrogen to calibrate the Green Bank-Maryland 21-cm line survey.

The following pulsar observations were conducted.

<u>Observer</u>	<u>Program</u>
M. Ewing (M.I.T.), D. Feith (M.I.T.), J. Krolik (M.I.T.), and D. Staelin (M.I.T.)	Observations at 110-235 MHz of a new X-ray source for evidence of periodic or single dispersed radio pulses with pulse periodicities of 10 milliseconds and longer.
R. Manchester	Observations from 250-500 MHz to continue pulsar polarization and timing measurements and to search for pulsar-like radiation in the Cyg X-1 X-ray source.

36-foot Telescope

	<u>Hours</u>
Scheduled observing	1813.25
Scheduled maintenance and equipment changes	254.0
Scheduled tests and calibration	116.75
Time lost due to: telescope and receiver failure	213.25
digital system failure	34.0
power	3.0
weather	19.25
interference	0

During this quarter a new type of 1 mm detector was tested on the telescope; also a 22-24 GHz spectral-line receiver, including a parametric amplifier, was successfully placed into operation.

<u>Observer</u>	<u>Program</u>
K. Johnston (NRL) and R. Hobbs (NASA-Goddard)	Observations of compact H II regions at 85 and 260 GHz.

<u>Observer</u>	<u>Program</u>
M. Kundu (Maryland) and R. Sinha (Maryland)	Circular polarization of quiet sun and active regions at 31 and 85 GHz.
E. Conklin and D. Heeschen	Observations of active elliptical galaxies at 31 and 85 GHz.
K. Johnson (Arizona)	Monitoring of 3C 120 for variability at 31 and 85 GHz.
H. Johnson (Lockheed)	Observations of symmetric galactic nebulae at 31 and 85 GHz.
A. Penzias (Bell Labs), R. Wilson (Bell Labs), and K. Jefferts (Bell Labs)	Further observations of the CO molecule at 115 GHz; detection of CH ₃ CN and OCS molecules.
P. Thaddeus (Goddard Institute), M. Kutner (Goddard Institute), A. Penzias (Bell Labs), R. Wilson (Bell Labs), and K. Jefferts (Bell Labs)	Investigation of ortho- and para-formaldehyde in dense clouds; detection of SiO at 130 GHz.
L. Snyder (Virginia) and D. Buhl	Further observations of HCN and X-ogen molecules; detection of CH ₃ C ₂ H, HNC, and HNC at 85-90 GHz.
D. Buhl, M. Roberts, and L. Snyder (Virginia)	Search for the HDO molecule at 80 GHz.
M. Simon (SUNY) and P. Berger (SUNY)	Search for solar recombination lines at 85 GHz.
B. Zuckerman (Maryland), P. Palmer (Chicago), and B. Turner	Search for HCO, HC ₃ HO, ClO and other molecules at 80-90 GHz.
J. Rather and R. Waniek (Advanced Kinetics)	Tests and observations of planets and extragalactic sources at 260 GHz.
D. Morrison (Hawaii) and E. Epstein (Aerospace)	Measurement of continuum flux density of Mars and some extragalactic variable sources at 85 GHz.
W. Dent (Massachusetts) and R. Hobbs (NASA-Goddard)	Measurement of flux densities of variable sources at 31 and 85 GHz.
V. Herrero, R. Hjellming, and C. Wade	Observations of radio novae at 85 GHz.
L. Snyder (Virginia), D. Buhl, and J. Edrich	Observations of H ₂ O and NH ₃ molecules; search for other molecules at 22-24 GHz.

<u>Observer</u>	<u>Program</u>
S. Gottesman	Attempt to detect H ₂ O in extragalactic nebulae at 22 GHz.
R. Rubin (Illinois), J. Dickel (Illinois) and B. Turner	Search for H ₂ O emission in H II and OH sources at 22 GHz.
P. Palmer (Chicago), B. Zuckerman (Maryland), and B. Turner	Study of NH ₃ emission and search for other molecules at 22-24 GHz.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

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

Inteferometer Development	14%
Interference Protection	2%
Very Long Baseline Interferometer	15%
24-GHz Receiver	6%
6-cm Receiver	3%
384-Channel Autocorrelation Receiver	12%
Visitor Support and Routine Maintenance	31%
21-cm Cooled Paramp	7%
Local Oscillator Development	5%
IF Processor Construction	5%

The interferometer spectral-line system was completed this quarter. The system provides 100° K system temperature in the 1370-1430 MHz frequency range and incorporates a new 384-channel cross-correlator for spectral analysis.

A front-end covering the 22-24 GHz range has been completed and installed on the 36-foot telescope. The system utilizes a tunable degenerate parametric amplifier developed by NRAO.

Construction of IF processing systems for the 140-foot and 300-foot telescopes has begun. These systems provide frequency conversion, amplification, filtering, and monitoring of the IF signal. Work is continuing on 21-cm cooled paramp development and construction of Mark II very-long-baseline interferometer terminals.

ENGINEERING DIVISION

The Engineering Division concentrated its efforts on the following projects during this quarter.

1. The tracking feed mount for the 300-foot telescope was assembled, installed on the antenna, and aligned. The unit has been performing satisfactorily since the installation in April.

2. A conceptual design for a 13-meter transportable antenna to operate with the existing interferometer at Green Bank has been completed. Specifications were prepared and invitations for proposals for the performance of the final design were issued.

3. Detailed design was completed for feed legs to replace the existing cable structure on the 36-foot telescope at Kitt Peak. This structure is being fabricated in the Central Shops at Green Bank and will be shipped to Kitt Peak for installation in August.

4. Design has been completed on a revised encoder mounting for the 36-foot telescope to permit interchangeable use of either Wayne-George or Baldwin encoders. This design will make possible more accurate installation of the encoders.

5. Installation and adjustment of exhaust fans to secure better ventilation on the second floor of the laboratory building at Green Bank was completed. Installation of air-conditioning in the basement and workshop area of the 140-foot telescope was completed.

6. At the 300-foot telescope, walkway support grating has been installed in surface panels to provide a walkway to the edge of the dish so that large equipment can be moved over the edge of the dish to the focal point. Additional grating is being installed in the center of the reflector to protect the surface against personnel traffic. Joints in the feed legs were reworked to remove any possible movement. Facilities are being provided to prevent escape of excess oil from the drive system into drainage waterways in the area.

7. Engineering work on the 65-meter telescope includes preparation of estimates of cost, preparation of site plans, completion of the design of the transition structure between the dish structure and the surface panels, and continued design work on the rotating elements of the vertex cabin. Specifications were prepared and invitations to proposers were issued for the performance of a design study to investigate alternate designs for a surface panel system for the proposed 65-meter homology telescope.

COMPUTER DIVISION

IBM 360/50 Computer Statistics

	<u>Summary</u>
Shift time (operating system)	2165 hours
Independent (not-operating system)	11 hours
Unscheduled down time	21 hours
Maintenance time	26 hours
<u>Usable time</u>	<u>2107 hours</u>
Total computer busy	2063.428
<u>Busy fraction of usable time</u>	<u>97.93%</u>
<u>Number of active users codes</u>	<u>131</u>
<u>Number of jobs run</u>	<u>14,835</u>

System Software (IBM 360)

Release 19 of the IBM-distributed operating system has been replaced by Release 20, although special adaptations of the latter for the NRAO configuration have not all been installed. Thus, for instance, the accounting system feature, described last quarter, which reports numbers of cards punched and lines printed, is lacking. Important improvements gained by early installation of Release 20 include ability to run the CalComp plotter at all times of the day simultaneously with HASP, certain features (e.g., sub-tasking) which greatly simplify the addition of CRT drivers to the system, and correction of a malfunction in the H-level Fortran compiler. The CRT-terminal "remote job entry" program now works with either the IBM 2741 type-writer or the Infoton Vista-1H CRT; the prototype CRT "remote-editing" program also works with 80-column records (IBM card format) but is undergoing further expansion. Usage is restricted to Computer Division systems programmers during this period of evaluation and improvement.

System Software (DDP116)

Two routines were contributed by Computer Division personnel to the new (spectral-line) interferometer system program: One for instantaneous Doppler calibration of a source's frequency offset; the other to do a complete (asymmetrical, complex) Fast Fourier Transform from 96-point, 192-point, or 384-point cross-correlation data into spectra.

User Software

The new TPOWER2 reduction program, for data from the new Model III (384 channel) correlation receiver, has been completed.

ANTENNA DESIGN

Homology Telescope

Work on the design of this telescope has continued throughout this quarter. The report on the completion of the phase of the work which shows the feasibility and cost of the telescope is in preparation. It shows that such a telescope can be built to give satisfactory performance, under good climatic conditions, at wavelengths as short as 3.5 millimeters.

NRAO SUMMER STUDENT PROGRAM

From a total of 180 applicants from 68 different colleges and universities, 28 students were accepted for our summer student program. Eight students are based in Green Bank, two in Tucson, and 18 in Charlottesville. These students, who are assigned to the scientific staff, the Electronics Division or Computer Division as research assistants, will spend at least 11 weeks at the Observatory.

Twenty-six lectures by the staff have been scheduled on various topics in radio astronomy and instrumentation; students are also encouraged to attend the

regular NRAO colloquia and seminars. This year each student, with the exception of the two in Tucson, will work a week in our public education program in Green Bank as a tour guide for the tourist who visit there at more than 1000 a week.

The NRAO initiated its program in 1959 with ten students. A total of 313 have participated in the program since then. Several NRAO summer students have returned as Ph.D. thesis students and some have joined the staff later as full-time employees.

The following list shows the 1971 summer students, their academic year just completed, their college and their hometown.

Name	Year	School	Hometown
Robert Boyle	4-U	Princeton University	Irvington-on-Hudson, N. Y.
David Burke	4-U	Purdue University	W. Lafayette, Ind.
Peter Camana	4-U	Lehigh University	Pennsburg, Penn.
Kenneth Cantrell	3-U	Western New England Col.	Quincy, Mass.
Brian Dennison	1-G	University of Louisville	Louisville, Ky.
Linda Dressel	4-U	University of Cincinnati	Cincinnati, Ohio
William Fawley	3-U	Princeton University	Glencoe, Ill.
Robert Freund	5-U	Virginia Polytechnic Inst.	Lancaster, Penn.
Paul Giguere	2-G	University of Virginia	N. Chelmsford, Mass.
Riccardo Giovanelli	2-G	Indiana University	Gattatico, Italy
Mark Hartoog	4-U	University of Michigan	Carleton, Mich.
Nelson Hoffman	1-G	University of Wisconsin	Pennington, N. J.
Robert Houck	1-G	Pennsylvania State Univ.	State College, Penn.
David Koo	3-U	Cornell University	New York, N. Y.
Charles Lada	4-U	Boston University	Webster, Mass.
Linda Lucignani	3-U	Wellesley College	Santurce, Puerto Rico
Robert Mutel	1-G	University of Colorado	Boulder, Colo.
Robert McMillan	3-U	Case Western College	Cleveland Heights, Ohio
Staffan Olson	1-G	Chalmers Univ. of Tech.	Goteborg, Sweden
Barbara Smith	2-G	Johns Hopkins	Richmond, Va.
Haywood Smith	4-G	University of Virginia	Charlottesville, Va.
Allan Spradling	4-U	University of Chicago	Kalamazoo, Mich.
Dennis Sweeney	4-U	Virginia Polytechnic Inst.	Lynchburg, Va.
Santiago Tapia	1-G	University of Arizona	Tucson, Arizona
Trinh Thuan	1-G	Princeton University	Saigon, S. Vietnam
Dennis Ward	2-G	Cornell University	Alberta, Canada
Patrick Yeung	3-U	Princeton University	Hong Kong
Mark Zabek	4-U	Cornell University	Worcester, Mass.

PERSONNEL

Appointments

Hugh S. Murdoch	Visiting Associate Scientist	April 6, 1971
*Thuppalay K. Menon	Visiting Scientist	June 18, 1971
*Carl E. Heiles	Visiting Scientist	June 21, 1971

* Temporary

Appendix A

OBSERVATORY COLLOQUIA

Outlined below is the NRAO colloquium program for the past fiscal year. The scientific staff usually invites the speakers, who talk on topics of current interest in radio astronomy or closely allied fields. The University of Virginia's Astronomy Department also invites speakers to participate in their own colloquium series. These series are announced jointly and are well attended by our staff, university physicists and astronomers and by students.

Name	Institution	Date
Robert V. Wagoner	Cornell University	July 9, 1970
V. Radhakrishnan	CSIRO, Sydney, Australia	July 17, 1970
Sigfrid Yngvesson	University of Massachusetts	August 3, 1970
George R. Carruthers	U.S. Naval Research Laboratory	September 24, 1970
R.H.T. Bates	University of Canterbury, New Zealand	October 16, 1970
J. Mayo Greenberg	State University of New York at Albany	October 22, 1970
R. H. Dicke	Princeton University	October 22, 1970
Richard Wielebinski	Max-Planck-Institut für Radio-astronomie, Bonn, W. Germany	November 11, 1970
Donald Osterbrock	University of Wisconsin	November 12, 1970
Bernard J. Eastlund	Atomic Energy Commission	November 19, 1970
Igor D. Novikov and Joseph S. Shklovsky	Mathematical Institute of the USSR Academy of Sciences, Moscow Sternberg Astronomical Institute, Moscow	December 11, 1970
William Quirk	California Institute of Technology	January 6, 1971
Bertram Donn	Goddard Space Flight Center, Greenbelt, Maryland	January 7, 1971
William K. Rose	Massachusetts Inst. of Technology	January 13, 1971
Alar Toomre	Massachusetts Inst. of Technology	January 28, 1971
Ian Lerche	Enrico Fermi Institute, University of Chicago	February 2, 1971
W. Miller Goss	Ex-CSIRO en route to Max-Planck-Institut für Radioastronomie, Bonn, W. Germany	February 4, 1971
Joseph Romig	University of Colorado	February 25, 1971
D. L. Jauncey	Cornell University	March 18, 1971
R. Ebert	Physikalisches Institute der Universität Würzburg	March 25, 1971
D. W. Goldsmith	University of California, Berkeley	April 6, 1971
G. C. Pimentel	University of California, Berkeley	April 21, 1971
Leonid Weliachew	Owens Valley Radio Observatory	May 4, 1971
P. Olof Lindblad	Stockholms Observatorium	May 14, 1971
Hugh S. Murdoch	University of Sydney, Australia	May 27, 1971
Vera C. Rubin	Dept. of Terrestrial Magnetism Carnegie Institution of Wash.	June 3, 1971
Harry van der Laan	Sterrewacht te Leiden	June 22, 1971

A list of Observatory reprints issued since June 30, 1970.

No.	Title	Author	Reference
<u>Series A</u>			
149	Lunar Occultation Observations of Jupiter at 74 cm and 128 cm	Samuel Gulkis	<u>Radio Science</u> , 5, 505, 1970
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