

213/GR BK/

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report

April 1, 1974 - June 30, 1974

RECEIVED
NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA

AUG 7 1974

RESEARCH PROGRAMS

<u>140-foot Telescope</u>	<u>Hours</u>
Scheduled observing	1837.50
Scheduled maintenance and equipment changes	314.75
Scheduled tests and calibration	14.00
Time lost due to: equipment failure	79.00
power	29.50
weather	0.00
interference	6.00

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
B. Burke (MIT)	Search at 500-750 MHz for neutral hydrogen absorption lines in the quasars PKS0237-23 and H1331+170.
P. Crane (MIT)	
T. Giuffrida (MIT)	
F. J. Lockman (Massachusetts)	Measurements at 853 MHz of H197 α recombination lines in Ori A.
R. Brown	
C. Gottlieb (Harvard)	Reobserve the 834 MHz methanol line in the region of the galactic center.
J. Ball (Harvard)	
A. Lilley (Harvard)	
H. Radford (Smithsonian)	
P. Mezger (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany)	Observations at 6-cm wavelength of recombination lines toward G355.3+0.1 and other General Catalog sources to supplement observations taken with the 100-meter MPIR, Bonn, W. Germany telescope.
T. Pauls (New Mexico State)	
B. Turner	Investigate the "clumping" of 6-cm H ₂ CO (formaldehyde) in Taurus. Map 18-cm OH emission in the galaxy and from Herbig-Haro objects and cometary nebulae.
W. Saslaw (Virginia)	Search for H ₂ CO (formaldehyde) in Cen A at 4830 MHz.
R. O'Connell (Virginia)	
B. Turner	

<u>Observer</u>	<u>Program</u>
H. Dickel (Illinois)	Measurements at 4830 MHz of H ₂ CO (formaldehyde) at OH positions and regions of high visual extinction in galactic nebulae and molecular clouds.
F. Clark (NBS)	Search at 4831 MHz for the 4 ₂₂ -5 ₁₅ transition and at 11.014 MHz for the J = 2 ₁₁ →2 ₀₂ transition of SO-dimer.
D. Johnson (NBS)	
F. Lovas (NBS)	
E. Chaisson (Harvard)	Observations at 4830 MHz to map the H ₂ CO (formaldehyde) line in M20 and at 4875 MHz to search for helium recombination lines toward K3-50.
R. Willson (Harvard)	
E. Chaisson (Harvard)	Study of 6-cm recombination lines in Ori A.
L. Goad (Harvard)	
F. J. Lockman (Massachusetts)	Observations at 6-cm wavelength of the H139 β recombination line in Sgr B ₂ .
B. Burke (MIT)	Observations of OH toward early-type stars at 1612, 1665, 1667, and 1720 MHz.
K. Lo (MIT)	
E. Chaisson (Harvard)	Observations of Zeeman splitting of OH at 1665 and 1667 MHz and of the 158 α recombination lines in dark clouds at 1659 MHz.
C. Beichman (U. Hawaii)	
L. Pataki (Indiana)	Study of time variations in the 1612, 1665 and 1667 MHz OH emission from Mira variables.
J. Kolena (Indiana)	
N. Kaifu (Tokyo Astronomical Observatory, Japan)	Map at 1665 and 1667 MHz OH emission in the galactic center region.
E. Tiemann (Freie U. of Berlin, W. Germany)	Observations in an attempt to verify detection of NH ₂ CHCH ₂ (vinylamine) at 1470.2 MHz.
D. Johnson (NBS)	
F. Lovas (NBS)	
F. Clark (NBS)	
B. Zuckerman (Berkeley)	Observations to check the possible detection of Al ²⁷ at 1506.1 MHz.
B. Turner	
H. Kroto (U. Sussex, England)	Search at 1330.4 MHz for CH ₃ HCS (thioacetaldehyde).
G. Blackman (Berkeley)	
W. Gwinn (Berkeley)	
B. Turner	

<u>Observer</u>	<u>Program</u>
L. Snyder (JILA)	Search for the following molecules: (1) HCN at 2693 MHz, (2) HCO at 2723.41, 2888.78 and 2891.78 MHz, (3) H ₂ CO at 2483.41 MHz, and (4) H ₂ CS at 3139.38 MHz.
D. Buhl	

The following continuum programs were conducted.

<u>Observer</u>	<u>Program</u>
D. Jauncey (Cornell)	Observations at 6-cm wavelength of the NRAO 6-cm survey sources to determine their incidence of variability.
J. Broderick (NAIC, Puerto Rico)	
J. Condon	
M. Kesteven (Queens, Canada)	Simultaneous observations at 3-cm wavelength to search for ultra-rapid (≈ 1 second) low-level variability in extragalactic sources using the Algonquin Radio Observatory, Canada 150-foot telescope and the NRAO 140-foot telescope.
T. Legg (NRC, Canada)	

The following very long baseline programs were conducted.

<u>Observer</u>	<u>Program</u>
D. Shaffer (Yale)	Observations at 2-cm wavelength to measure a number of radio galaxies and quasars to investigate their small-scale structure and its variation with time using the Goldstone 210-foot telescope, the Haystack 120-foot telescope, and the NRAO 140-foot telescope.
A. Niell (JPL)	
B. Clark	
K. Kellermann	
G. Purcell	
T. Clark (NASA, Greenbelt)	Observations at 3.8-cm wavelength of the structure of quasars and related objects and for performing geodetic and astrometric studies using the Goldstone 210-foot telescope, the Onsala, Sweden 84-foot telescope, and the NRAO 140-foot telescope.
A. Rogers (Haystack)	
I. Shapiro (MIT)	
J. Punskey (MIT)	
A. Whitney (MIT)	
D. Robertson (MIT)	
H. Hinteregger (MIT)	
C. Counselman (MIT)	
A. Niell (JPL)	
D. Spitzmesser (JPL)	
L. Hutton (Maryland)	Measurements of the structure of compact sources using the Goldstone 210-foot telescope, the Haystack 120-foot telescope and the NRAO 140-foot telescope.
G. Marandino (Maryland)	
R. Schilizzi (Caltech)	
A. Niell (JPL)	
K. Kellermann	
E. Fomalont	
B. Clark	

<u>Observer</u>	<u>Program</u>
K. Johnston (NRL) S. Knowles (NRL) J. Moran (Smithsonian) G. Mader (Maryland)	Observations to determine the precise relative positions of 18-cm OH and 1.4-cm water vapor masering regions in OH/H ₂ O sources using the NRL 85-foot telescope and the NRAO 140-foot telescope.
B. Burke (MIT) K. Johnston (NRL) J. Moran (Smithsonian)	Measurements of 1720 MHz OH in V1057 Cygni and other sources using the NRL 85-foot telescope, the OVRO 130-foot telescope, and the NRAO 140-foot telescope.
D. Shaffer (Yale) R. Schilizzi (Caltech)	Measurements at 18-cm wavelength of 8-10 quasars using the OVRO 130-foot telescope and the NRAO 140-foot telescope.
B. Burke (MIT) K. Lo (MIT) K. Johnston (NRL) J. Moran (Smithsonian)	Observations at 6-cm wavelength to study type N galaxies, quasars, HII regions, Cyg A, IC342, Sgr A, and Sgr B2 using the NRL 85-foot telescope and the NRAO 140-foot telescope.
I. Pauliny-Toth (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany) E. Preuss (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany) A. Witzel (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany) N. Broten (NRC, Canada) J. Yen (NRC, Canada) D. Fort (NRC, Canada) A. Moffet (Caltech) M. Cohen (Caltech) R. Schilizzi (Caltech) J. Romney (Caltech) D. Shaffer (Yale) R. Rhinehart (Harvard, Fort Davis) K. Kellermann G. Purcell	Observations using the MPIR, Bonn, W. Germany 100-meter telescope, the Algonquin Radio Observatory, Canada 150-foot telescope, the Harvard, Fort Davis 85-foot telescope, the OVRO 130-foot telescope, and the NRAO 140-foot telescope.

In addition to the above programs, F. Kerr (Maryland), D. Buhl, and A. Parrish measured transmissions of the ATS-6 satellite to measure the levels of radio interference to the radio astronomy service in the 2690-2700 MHz band.

InterferometerHours

Scheduled observing	1844.25
Scheduled maintenance and equipment changes	154.25
Scheduled tests and calibration	185.50
Time lost due to: equipment failure	132.75
power	37.75
weather	34.50
interference	5.00

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

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

ObserverProgram

H. Dickel (Illinois)	Search for radio emission from early-type stellar objects using the 4-element interferometer with the 45-foot telescope over a 35-km baseline.
K. Lo (MIT)	
B. Burke (MIT)	
P. Crane (MIT)	
J. Wardle (Brandeis)	Flux density and polarization measurements of approximately 80 radio sources.
D. Altschuler (Brandeis)	
K. Kellermann	Monitor of approximately 10 sources for flux variability.
J. Carlson (Maryland)	Extension of a program to measure Seyfert and related galactic nuclei using the 45-foot telescope over a 35-km baseline.
F. Kerr (Maryland)	
E. Fomalont	Observations utilizing the 45-foot telescope over a 35-km baseline to measure the gravitational deflections of a radio source near the sun.
R. Sramek	
T. K. Menon (Tata Institute, Bombay, India)	Observations to determine the structure of 20 selected sources, at 8085 MHz only, which have been studied using lunar occultation techniques at 327 MHz with the Ooty radio telescope in India.
C. Purton (York University, Toronto, Canada)	Attempt to detect radio emission from early-type emission line stars using the 4-element interferometer with the 45-foot telescope at a 35-km baseline.
P. Feldman (York University, Toronto, Canada)	
K. Marsh (York University, Toronto, Canada)	

<u>Observer</u>	<u>Program</u>
D. Gibson (Virginia)	Investigation of variable radio emission in binary stars.
F. Owen	Observations of Abell clusters of galaxies using the 45-foot telescope over a 35-km baseline.
B. Burke (MIT) K. Lo (MIT)	Observations of continuum emission from OH/H ₂ O sources with compact radio components using the 45-foot telescope over a 35-km baseline.
R. Becker (Maryland) M. Kundu (Maryland)	Polarization and small-scale structure measurements in five possible supernova remnants.
H. Perley (Maryland)	Study of localized emission regions in well-resolved, extended radio galaxies using the 45-foot telescope over a 35-km baseline.
E. Seaquist (U. Toronto, Canada) R. C. Bignell	Observations of a selected group of 14 spiral galaxies and of 5 radio stars using the 45-foot telescope over a 35-km baseline.
E. Seaquist (U. Toronto, Canada) J. Dickel (Illinois)	Observations of G74.1+1.2 to investigate its size and physical nature using the 45-foot telescope over a 35-km baseline.
E. Seaquist (U. Toronto, Canada) P. Gregory (U. British Columbia, Canada) A. Davidsen (Berkeley)	Search for radio emission from the X-ray source 3U0614+09.
M. Kundu (Maryland) R. Becker (Maryland) C. Alessandrakis (Maryland)	Brightness temperature measurements of fine structure components in solar emission regions.
S. Anand	Search for radio emission from nearby stars.
E. Fomalont K. Kellermann	Attempt to detect compact source components in the nuclei of galaxies or coincident with quasars.
N. Keen (Max-Planck-Institut für Radioastronomie, Bonn, W. Germany) D. Hogg	Measurements of the point source 2048+31 in the Cygnus Loop using the 45-foot telescope over a 35-km baseline.

<u>Observer</u>	<u>Program</u>
R. Price (MIT)	Survey of 200 spiral galaxies using the 4-element interferometer with the 45-foot telescope over a 35-km baseline.
P. Crane (MIT)	
D. Jauncey (Cornell)	Accurate position measurements to confirm the identification of highly red-shifted blue stellar objects.
M. Yerbury (Cornell)	
J. Condon	

The following line observations were conducted.

<u>Observer</u>	<u>Program</u>
E. Greisen	Observations at 2702 MHz of H134 α recombination line emission from HII regions.
R. Brown	
E. Greisen	Aperture synthesis observations of 21-cm neutral hydrogen in W3, Ori A, W49 and W51.

The following pulsar observations were conducted.

<u>Observer</u>	<u>Program</u>
D. Backer (NASA, Greenbelt)	Observations to determine pulsar proper motions using the 45-foot telescope over a 35-km baseline.
R. Sramek	

In addition to the above observations, F. Kerr (Maryland) and E. Greisen measured transmissions from the ATS-6 satellite to measure the levels of radio interference to the radio astronomy service in the 2690-2700 MHz band.

300-foot Telescope

	<u>Hours</u>
Scheduled observing	2046.00
Scheduled maintenance and equipment changes	138.00
Scheduled tests and calibration	0.00
Time lost due to: equipment failure	50.00
power	36.25
weather	1.75
interference	12.25

The following line programs were conducted during this quarter.

<u>Observer</u>	<u>Program</u>
F. Kerr (Maryland)	Search a large portion of the sky at 1612 MHz for the brighter OH point sources believed to be associated with late-type variable stars.
P. Bowers (Maryland)	
S. Simonson (Maryland)	

<u>Observer</u>	<u>Program</u>
G. S. Shostak M. Roberts	Studies of the distribution of 21-cm neutral hydrogen in approximately 1000 spiral and elliptical galaxies.
G. Knapp (Maryland) R. Brown	Search at 21-cm wavelength for carbon recombination lines in nebulae associated with Be stars.
R. Tully (Observatoire de Marseille, France) J. R. Fisher	Measurements at 1421 MHz of (1) neutral hydrogen in dwarf galaxies and (2) a search for optically invisible galaxies.
G. S. Shostak	Search at the 1421-MHz line of neutral hydrogen for optically invisible galaxies.
B. Burke (MIT) A. Haschick (MIT)	Search at 1421 MHz for absorption in selected quasistellar objects due to neutral hydrogen in nearby galaxies.
V. Rubin (DTM) N. Thonnard (DTM)	Measurements of 1421 MHz neutral hydrogen in ScI galaxies which are in the magnitude interval 14-15 and in bright, late-type spirals between magnitude 12.5 and 14.
F. J. Lockman (Massachusetts)	Study of the behavior of recombination lines from distributed HII at 577 and 613 MHz.

The following continuum programs were conducted.

<u>Observer</u>	<u>Program</u>
D. Gibson (Virginia) F. Owen R. Hjellming	Search at 5006 MHz for new radio stars.
W. Erickson (Maryland) J. R. Fisher	Study at 750-1000 MHz for low-frequency radio source variability coordinated with observations conducted at the Clark Lake radio telescope.
G. Brandie (Queens, Canada) A. Bridle (Queens, Canada) M. Kesteven (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.

<u>Observer</u>	<u>Program</u>
J. Kapitzky (Massachusetts)	Monitor at 2695 MHz the flux density and polarization of known variable extragalactic sources and a continued search for other variable sources.
W. Dent (Massachusetts)	

The following pulsar program was conducted.

<u>Observer</u>	<u>Program</u>
D. Backer (NASA, Greenbelt)	Observations of pulsar density spectra over the frequency range 740-1000 MHz and at 1420 MHz, coordinated with 156 MHz observations at Five Colleges Radio Astronomy Observatory.
J. R. Fisher	

36-foot Telescope

	<u>Hours</u>
Scheduled observing	2031.25
Scheduled maintenance and equipment changes	112.75
Scheduled tests and calibration	40.00
Time lost due to: telescope and receiver failure	101.75
digital system failure	102.00
power	32.50
weather	16.50
interference	0.00

<u>Observer</u>	<u>Program</u>
K. Kellermann	Continuum observations of sources with peculiar spectra and with non-variable fluxes.
M. Morris (Chicago)	Galactic survey of ammonia and study of ammonia distribution in the galactic center.
P. Palmer (Chicago)	
B. Zuckerman (Berkeley)	
B. Turner	
M. Kaifu (Tokyo Astronomical Obs.)	Ammonia maps of the galactic center.
M. Morris (Chicago)	
P. Palmer (Chicago)	
B. Zuckerman (Berkeley)	
B. Turner	
W. Dent (Massachusetts)	Flux density variations of variable extragalactic radio sources.
R. Hobbs (NASA-Greenbelt)	
F. Kerr (Maryland)	Continuum observations of dust clouds.
A. Milman (Maryland)	

<u>Observer</u>	<u>Program</u>
B. Ulich	Measurement of the linear polarization of 3C273.
F. Kerr (Maryland)	Investigation of CO shock fronts compared with HI observations.
W. Wilson (Aerospace Corporation)	
S. Simonson (Maryland)	
P. Schwartz (NRL)	
F. Kerr (Maryland)	Study of CO density distribution and $^{12}\text{C}/^{13}\text{C}$ ratio in dense interstellar clouds.
G. Knapp (Caltech)	
R. Cornett (Maryland)	
E. Epstein (Aerospace Corporation)	
W. Wilson (Aerospace Corporation)	
F. Kerr (Maryland)	Study of CO emission lines in the directions of dust clouds in front of HII regions.
A. Milman (Maryland)	
G. Knapp (Caltech)	
W. Wilson (Aerospace Corporation)	
A. Milman (Maryland)	CO observations of dust clouds.
F. Kerr (Maryland)	
W. Wilson (Aerospace Corporation)	
G. Knapp (Caltech)	
W. B. Burton	Fine grid survey of CO around the galactic center with wide velocity coverage.
R. Sanders	
H. Liszt	
H. Liszt	CO studies in IR and continuum sources.
S. Mufson	
M. Morris (Chicago)	Mapping of HCN, CS and CO lines.
P. Palmer (Chicago)	
B. Turner	
B. Zuckerman (Berkeley)	
W. Gilmore (Maryland)	
M. Gordon	Investigation of galactic structure with CO lines
T. Bania (Virginia)	
W. B. Burton	
F. J. Lockman (Massachusetts)	
L. Snyder (JILA)	Observations of X-ogen and search for H^{13}CO .
J. M. Hollis	
D. Buhl	
P. Giguere (NASA, Greenbelt)	HCN in early-type stars and in carbon stars.
L. Snyder (JILA)	
D. Buhl	

<u>Observer</u>	<u>Program</u>
D. Johnson (NBS) F. Lovas (NBS) D. Buhl L. Snyder (JILA) F. Clark (NBS)	Search for thioformaldehyde and cyanoacetylene.
L. Snyder (JILA) P. Schwartz (NRL) D. Johnson (NBS) F. Clark (NBS) P. Giguere (NASA, Greenbelt) F. Lovas (NBS) D. Buhl	Search for dimethyl ether.
D. Buhl L. Snyder (JILA)	HCN maps of the Sagittarius region.
L. Snyder (JILA) D. Buhl N. Kaifu (Tokyo Astronomical Obs.)	Survey of SiO maser sources and search for SiO isotopes.
N. Kaifu (Tokyo Astronomical Obs.) K. Takagi (Rice)	Search for methylamine.
B. Ulich R. Haas	Absolute calibration of standard mole- cular line sources.
B. Turner H. Kroto (Sussex-Brighton, England) G. Blackman (Berkeley) W. Gwynn (Berkeley)	Search for CH ₃ HCS.
R. Gammon (Mackenzie U., Brazil) B. Turner	Study of H ₂ CO at 48 GHz.
B. Turner M. Morris (Chicago) P. Palmer (Chicago) B. Zuckerman (Berkeley) W. Gilmore (Maryland)	Study of cyanoacetylene.
C. Gottlieb (Harvard/Smithsonian) C. Lada (Harvard/Smithsonian) M. Litvak (Harvard/Smithsonian) A. E. Lilley (Harvard/Smithsonian)	Observations of CS and isotopes in M17, Orion A, NGC 1333 and ρ -Oph.
C. Gottlieb (Harvard/Smithsonian) J. Ball (Harvard/Smithsonian)	Study of methanol at 48 GHz.

<u>Observer</u>	<u>Program</u>
L. Snyder (JILA) D. Buhl	Search for X-ogen line in various sources.
P. Thaddeus (NASA, Greenbelt) G. Blair (Texas) J. Davis (Texas)	Search for vibrationally excited SiO in infrared stars and in H ₂ O and OH sources.
R. Martin (MIT) P. Ho (MIT) A. Barrett (MIT)	Search for CH ₃ NH ₂ and for CS in small galactic dark clouds.
A. Penzias (Bell Labs) R. Wilson (Bell Labs) P. Wannier (Princeton)	Isotopic abundance ratios in molecular line emission sources.
K. Bechis (MIT) K. Lo (MIT)	Mapping of ¹² CO and ¹³ CO emission around early-type stars.
S. Gottesman (Florida) A. Seacord (Florida)	CO survey of the Cygnus-X region.

ELECTRONICS DIVISION--EQUIPMENT DEVELOPMENT

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

500-740 MHz Receiver	3%
VLBI Effort	6%
Interference Protection	3%
Antenna Development	5%
256-Channel Multifilter Receiver	4%
Visitor Support and Routine Maintenance	30%
Improved LO System	2%
Cooled Mixer Receiver	10%
140-ft Cassegrain Receiver	13%
VLA Support	14%
Interferometer Digital Delay	5%
Nutating Sub-reflector	5%

The 4-frequency Cassegrain front-end (which will be used on the 140-foot telescope) has been installed in a Cassegrain-focus equipment box. Initial system noise temperature measurements gave 42° K at 21 cm, 41° K at 6 cm, 250° K at 2 cm, and 400° K at 1.25 cm. Work is in progress to improve these results and improve stability prior to the August installation date.

Initial tests of the 80-120 GHz cooled mixer receiver revealed problems with RFI pickup (at low frequencies), some instabilities, and poor noise temperatures in the 80-90 GHz range. The first two problems have been reduced but reduction of the 80-90 GHz noise temperature will require further work.

The interferometer digital-delay system for spectral-line work has been completed and is in operation.

A new hydrogen maser has been received from Smithsonian Astrophysical Observatory and after considerable difficulties is now operating properly.

ENGINEERING DIVISION

The main emphasis of the Engineering Division this quarter has been toward the design of various components for the 140-foot Cassegrain system. This includes assisting in interfacing the subreflector and nutating systems, expediting the air-conditioning system for the vertex building, preparation for ground testing of the Sterling mount and nutating system, and assisting in the preparation of the telescope for the installation.

Engineering assistance was provided in the preliminary studies of a new millimeter telescope, the VLA transporter design, the VLA site and building design, the proposed updating of the 36-foot receiver cooling system, the proposed updating of the 36-foot automated feed mount and the remodeling of the basement of the medical building at the Green Bank site for a dentist office.

COMPUTER DIVISION

360 System - The disc subsystem used with the IBM 360/65 computer has been upgraded. The IBM (2314 type) disc subsystem (300 M bytes) has been replaced by a Memorex 3330 type system having a capacity of 600 M bytes.

140-foot Telescope - Universal Local Oscillator (ULO) System. Installation and programming has been completed on the ULO at the 140-foot telescope.

140-foot Display - The control panel CRT system has been completed. One display indicates encoder positions, sidereal time, and servo position and rate errors on a permanent basis. The second CRT may be switched to display either commanded or actual positions in any allowable coordinate system.

Continuum Software - The first two phases of the continuum software package are nearing completion. All standard techniques of data collection are supported. The advanced program, using the "Direct Modular Approach" are nearly complete. Working verbs include single and two-dimensional Gaussian model fitting, interactive CRT terminals, and both CRT and CalComp mapping. Development is in the user-programmer tuning stage.

VERY LARGE ARRAY PROJECT

Site and Wye Division

The right of way easements for the five tracts of land required for site construction, Phase I, have all been obtained.

An "Intensive Survey" has been conducted by Dr. Stanley D. Bussey, Assistant Professor of Anthropology, New Mexico State University, who performed an on-the-ground inspection of the central site section and thirteen thousand linear feet of the southwest arm. The area is reported clear except for one minor archaeological site in the central area consisting of a few stone flakes believed dating from the Late Chiricahua Stage or the Early San Pedro Stage of the Cochise. The find was determined to be of no particular archaeological interest after three test pits were dug without indicating any subsurface evidence of human occupation. The survey is presently being extended to cover the remaining portions of the wye.

Antenna Division

Antenna - Amendment No. 6 to Subcontract VLA-6 has been issued extending the design phase until July 31, 1974, and delaying the start of antenna fabrication until August 30, 1974 owing to a weight reduction effort undertaken by E-Systems. Plans are being formulated which should allow recovery of the slippage, and no impact of this delay is expected to be felt on delivery of the antennas.

The design review of the E-Systems' antenna is in process. Effort is being expended by both the VLA Antenna Engineering group and E-Systems to review and clarify the interface requirements of the electrical system, the data systems, and the servo areas.

Transporter - E-Systems was not able to meet the design completion date of May 30, 1974 as specified in Subcontract VLA-10. Completion of the design is now expected by July 15, 1974. Plans are being made to negate the impact of this slippage on delivery of the end item through schedule recovery.

Preliminary drawings have been submitted by E-Systems to the VLA antenna engineering department, which has completed an initial review of the drawings and provided E-Systems with the appropriate feedback.

Antenna Assembly Building - E-Systems has submitted erection and outline drawings of the building along with the design calculations prepared by the building subcontractor to the VLA antenna engineering group. The drawings and calculations have been reviewed and pertinent comments have been transmitted to E-Systems.

Electronics Division

The principal effort has been directed towards the procurement of the prototype electronics subsystem.

A prototype of the full 60 mm diameter waveguide transmission coupler is currently under fabrication.

A meeting was held on April 5, 1974 with representatives from the Western Electric Company and Bell Telephone Laboratories in which Western Electric agreed to furnish ninety meters of dielectric waveguide and forty-five meters of helix for testing and evaluation of its suitability for the VLA project. This waveguide was received at Green Bank in early June and the helix is expected in early July.

The preliminary design phase of the delay and multiplier microcontroller has been completed. All of the high-speed logic board and mother boards for the digital delay and correlator system have been fully tested and approved.

The following prototype units have been completed and successfully tested: the IF amplifier module and the 2-4 GHz locked oscillator module. Final design is also complete on the digital synthesizer module.

Computer Division

Work has commenced regarding the assignment of detailed tasks to the four minicomputer systems which make up the synchronous subsystem of the continuum computer system. Effort has also begun on the development of software for the asynchronous subsystem of the continuum computer.

Project Management

Effort is being made to obtain government surplus rail for use on the wye. Transfer from Mountain Home AFB of 6900 feet of 70 pound rail for the maintenance vehicle siding has been initiated and is awaiting the arrangement for a government bill of lading by the Foundation. An agreement is being formulated with the Alaskan Railroad whereby the total cost incurred in the rail take-up at Crab Orchard Wildlife Refuge will be equally divided. The VLA Project will receive approximately six miles of track from the Crab Orchard arrangement. Five railroad cars destined for the VLA site have been loaded with rail.

Major Procurements

The following is a listing of the major procurements made during the past quarter: Subcontract VLA 34 was awarded to the Burn Construction Company at a cost of \$605,000 for Site Construction, Phase I; Purchase Order No. 045312 (re: VLA 43) was issued to Modular Computer Systems at a cost of \$248,615.95 for four minicomputer systems and accessories; Subcontract VLA 44 was awarded to the Digital Equipment Corporation for the asynchronous computer subsystem in the amount of \$767,308; Purchase Order No. 045752 was issued to Longwill-Scott, Inc. for the take-up of rail and accessories at Crab Orchard, Illinois, with an estimated credit to the VLA Project of \$13,772.

GALACTIC CENTER SEMINAR

On April 8, 9 and 10, 1974, a seminar on the galactic nucleus was held in Charlottesville. A total of 50 scientists, representing 27 different institutions throughout the U.S., Europe and Australia, participated in the seminar. The meeting was informal, and the discussions covered a range of topics from radio, infrared, and high-energy observations of the galactic nucleus to theoretical descriptions of phenomena occurring in the central region of our own galaxy.

SUMMER STUDENT PROGRAM

Announcement of our 1974 summer student program was sent to about 70 colleges and universities in December. From the more than 100 applications received, 19 students were selected to participate in the program as research assistants to the scientific staff and in the electronics and computer divisions. Six students are working in Green Bank and 13 in Charlottesville. These students will spend at least 11 weeks at the NRAO. Twenty-eight lectures 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 our public education program in Green Bank.

A total of 388 students have participated in the program since its beginning in 1959. Several students have returned to NRAO as thesis students and some as full-time employees.

The names of the 1974 students, their academic year, school and hometown are given below.

Name	Year	Affiliation	Hometown
Balonek, T. J.	U-4	Cornell	Rochester, New York
Benson, J.	U-4	U. Iowa	Fort Dodge, Iowa
Burns, J. O.	U-4	U. Massachusetts	Shirley, Massachusetts
Da Cota, L. A.	U-4	Brandeis	Rio de Janerio, Brazil
Gomez-Gonzales, J.	G	Observatoire de Paris	Madrid, Spain
Hakansson, B.	G	Chalmers University	Gothenburg, Sweden
Hawley, S.	G-1	U. California	Salina, Kansas
Haynes, M.	G-1	Indiana U.	Bloomington, Ind.
Hirsch, S.	U-5	Drexel	Havertown, Pennsylvania
Holm, D.	G-1	U. California	Tucson, Arizona
Ja Folla, J.	U-4	Drexel	Havertown, Pennsylvania
Jones, D.	U-4	Carleton	Philadelphia, Pennsylvania
Pariseau, R.	U-4	Princeton	Laurel, Maryland
Rothman, T.	U-3	Swarthmore	Trenton, New Jersey
Simila, J.	U-3	Harvard	Salla, Finland
Stinebring, D.	U-3	Williams College	South Burlington, Vermont
Thorstensen, J.	U-4	Haverford	Delmar, New York
Veenhuyzen, C.	U-4	Pomona	Santa Ana, California
Waldhuter, J.	U-4	Columbia	Jamaica, New York

PERSONNEL

Appointments

David W. Weber	Electronics Engineer I	April 24, 1974
David A. Webb	Business Manager - Tucson	May 28, 1974
Stanley S. Hansen	Scientific Programming Analyst II	June 10, 1974

Terminations

S. P. S. Anand	Visiting Assistant Scientist	June 28, 1974
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Leave of Absence

Shirley L. Huang	Scientific Programmer II	May 31, 1974
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Return from Leave of Absence

Sebastian von Hoerner	Scientist	June 1, 1974
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OBSERVATORY COLLOQUIA

The twenty-four speakers in the NRAO colloquium program for the past fiscal year 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 two series are jointly announced and well attended by our staff, university physicists and astronomers and students.

Name	Institution	Date
D. Altschuler	Brandeis University	Feb. 28, 1974
R. H. Bates	University of Canterbury, New Zealand	Aug. 29, 1973
E. E. Becklin	California Institute of Technology	April 11, 1974
E. B. Churchwell	Max-Planck Institut für Radioastronomie, Bonn, W. Germany	Nov. 2, 1973
D. P. Cox	University of Wisconsin	Nov. 15, 1973
H. C. Gerola	Joint Institute for Laboratory Astrophysics	Feb. 14, 1974
T. Gold	Cornell University	Oct. 23, 1973
D. W. Goldsmith	State University of New York, Stony Brook	Jan. 24, 1974
C. E. Heiles	University of California, Berkeley	Dec. 27, 1973
V. Icke	University of Cambridge, England	April 4, 1974
F. Israel	Leiden Observatory, Netherlands	June 20, 1974
L. W. Kamp	National Aeronautics and Space Administration, Greenbelt	Feb. 21, 1974
T. K. Menon	Tata Institute, Bombay, India	April 16, 1974
P. G. Mezger	Max-Planck-Institut für Radioastronomie, Bonn, W. Germany	April 19, 1974
E. Raimond	Netherlands Foundation for Radio Astronomy, Leiden, Netherlands	June 13, 1974
G. A. Seielstad	Owens Valley Radio Observatory	June 27, 1974
D. B. Shaffer	Yale University	Dec. 13, 1973
W. W. Shane	Leiden Observatory, Netherlands	Aug. 8, 1973
P. G. Sutherland	Columbia University	Feb. 27, 1974
P. Thaddeus	Goddard Institute for Space Studies	Feb. 7, 1974
N. R. Vandenberg	University of Maryland	Feb. 19, 1974
P. van der Kruit	Hale Observatories	April 5, 1974
J. C. Webber	University of Illinois	June 6, 1974
J. P. Wild	CSIRO, Sydney, Australia	Nov. 5, 1973

A list of Observatory reprints issued since June 30, 1973.

No.	Title	Author	Reference
<u>Series A</u>			
284	The Manifold of Galaxies	P. Brosche	<u>Astron. Astrophys.</u> , 23, 259, 1973
285	Molecules and Evolution in the Galaxy	D. Buhl	<u>Sky Telesc.</u> , 45, 156, 1973
286	Lunar Occultations of the Galactic Center Region in HI, OH and H ₂ CO Lines. I. Observations and Contour Maps	Aa. Sandqvist	<u>Astron. Astrophys.</u> , Suppl., 9, 391, 1972
287	An Optical Distance Measuring Instrument	J. M. Payne	<u>Rev. Sci. Instrum.</u> , 44, 304, 1973
288	Polarization of the Supernova Remnant HB21 at 11-cm Wavelength	M. R. Kundu R. H. Becker T. Velusamy	<u>Astron. J.</u> , 78, 170, 1973
289	The Temperature of the Turbulent Intercloud Medium	P. L. Baker V. Diadiuk	<u>Astrophys. Lett.</u> , 13, 199, 1973
290	On the Kinematics of a Local Component of the Interstellar Hydrogen Gas Possibly Related to Gould's Belt	P. O. Lindblad K. Grape Aa. Sandqvist J. Schober	<u>Astron. Astrophys.</u> , 24, 309, 1973
291	Some Modulus Arithmetic Algorithms for Binary Logic	B. G. Clark	<u>Rev. Sci. Instrum.</u> , 44, 644, 1973
292	The Nature of the First Cygnus X-3 Radio Outburst	P. C. Gregory P. P. Kronberg E. R. Seaquist V. A. Hughes A. Woodsworth M. R. Viner D. Retallack R. M. Hjellming B. Balick	<u>Nature-Phys. Sci.</u> , 239, 114, 1972
293	The Effect of Loop III on Interstellar Neutral Hydrogen	I. Fejes G. L. Verschuur	<u>Astron. Astrophys.</u> , 25, 85, 1973
294	31.4-GHz Flux Density Measurements of Variable Radio Sources	W. A. Dent R. W. Hobbs	<u>Astron. J.</u> , 78, 163, 1973
295	Small Scale Individual Features in the Local Neutral Hydrogen	P. L. Baker	<u>Astron. Astrophys.</u> , 26, 203, 1973.

No.	Title	Author	Reference
296	Observations of Galactic Supernova Remnants at 1.7 and 2.7 GHz	A. G. Willis	<u>Astron. Astrophys.</u> , 26, 237, 1973
297	Observations of Sixteen Interstellar Dust Clouds	G. R. Knapp F. J. Kerr	<u>Astron. J.</u> , 78, 453, 1973
298	Particle Injection in the Cygnus X-3 Radio Outburst	F. W. Peterson	<u>Nature</u> , 242, 173, 1973
299	A Search for OH/IR Stars in Globular Clusters	G. R. Knapp F. J. Kerr	<u>Astron. J.</u> , 78, 458, 1973
300	A Green Bank Sky Survey in Search of Radio Sources at 1400 MHz. IV. Anisotropy and Counts of Radio Sources	J. Maslowski	<u>Astron. Astrophys.</u> , 26, 343, 1973
<u>Series B</u>			
380	Population Explosion and Interstellar Expansion	S. von Hoerner	<u>Einheit und Vielheit Festschrift für C.F.v.Weizsäcker</u> , p. 221, 1973 (Gottingen, Vandenhoeck & Ruprecht)
381	Extended Extragalactic Radio Sources	D. S. De Young G. Burbidge	<u>Comments Astrophys. Space Phys.</u> , 5, 29, 1973
382	The Definition of Rest in Empty Universes	S. von Hoerner	<u>Astrophys. J.</u> , 181, 261, 1973.
383	Infrared and Radio Observations of the Nucleus of NGC 253	E. E. Becklin E. B. Fomalont G. Neugebauer	<u>Astrophys. J.</u> , 181, L27, 1973
384	HCN Radio Emission from the Hourglass Region of M8	P. T. Giguere L. E. Snyder D. Buhl	<u>Astrophys. J.</u> , 182, L11-L12, 1973
385	Radio Variability of HDE 226868 (Cygnus X-1)	R. M. Hjellming	<u>Astrophys. J.</u> , 182, L29-L31, 1973
386	Variations in the Radio Structure of BL Lacertae	B. G. Clark K. I. Kellermann M. H. Cohen D. B. Shaffer J. J. Broderick D. L. Jauncey L. I. Matveyenko I. G. Moiseev	<u>Astrophys. J.</u> , 182, L57, 1973.

No.	Title	Author	Reference
387	Interstellar Deuterium: The Hyper-fine Structure of DCN	R. W. Wilson A. A. Penzias K. B. Jefferts P. M. Solomon	<u>Astrophys. J.</u> , 179, L107, 1973
388	Interferometric Observations of Formaldehyde Absorption in Front of Strong Galactic Sources	E. B. Fomalont L. Welachew	<u>Astrophys. J.</u> , 181, 781, 1973
389	A Survey of Radio Recombination Lines Toward the Galactic Center	F. J. Lockman M. A. Gordon	<u>Astrophys. J.</u> , 182, 25, 1973
390	Observations of Uranus and Saturn by a New Method of Radio Interferometry of Faint Moving Sources	F. H. Briggs	<u>Astrophys. J.</u> , 182, 999, 1973.
391	Studies of Interstellar Formamide	C. A. Gottlieb P. Palmer L. J. Rickard B. Zuckerman	<u>Astrophys. J.</u> , 182, 669, 1973
392	Fine Structure in NGC 7027	B. Balick C. Bignell Y. Terzian	<u>Astrophys. J.</u> , 182, L117, 1973
393	Radio Interferometry of Moving Sources in the Presence of Confusion. An Application to Mercury at 21-cm Wavelength	F. H. Briggs F. D. Drake	<u>Astrophys. J.</u> , 182, 601, 1973
394	Absence of H ₂ CO 6-Centimeter Hyper-fine Anomalies in a Dust Cloud	C. Heiles B. E. Turner	<u>Astrophys. J.</u> , 182, L121, 1973.
395	Upper Limits for Interstellar Fulvene and Nitric Acid	P. T. Giguere F. O. Clark L. E. Snyder D. Buhl D. R. Johnson F. J. Lovas	<u>Astrophys. J.</u> , 182, 477, 1973.
396	Supernova Remnant HB 21 and Pulsar PSR 2021+51	G. L. Verschuur	<u>Astrophys. J.</u> , 183, L9, 1973
397	New Interstellar Methanol Lines	M. L. Kutner P. Thaddeus A. A. Penzias R. W. Wilson K. B. Jefferts	<u>Astrophys. J.</u> , 183, L27, 1973
398	Radio Emission from the Close Binary β Persei	R. M. Hjellming C. M. Wade	<u>Nature</u> , 242, 250, 1973

No.	Title	Author	Reference
399	The Radio Detection of a Giant Dust Complex in the Perseus Arm	B. Höglund M. A. Gordon	<u>Astrophys. J.</u> , 182, 45, 1973
400	The Absence of Formaldehyde Radiation Toward Cold Regions of the Galactic Plane: Further Investigation	M. A. Gordon B. Höglund	<u>Astrophys. J.</u> , 182, 41, 1973
401	Simulation of Driven Flare-Associated Disturbances in the Solar Wind	D. S. De Young A. J. Hundhausen	<u>J. Geophys. Res.</u> , 78, 3633, 1973
402	A Search for Narrow Band 21-cm Wavelength Signals from Ten Nearby Stars	G. L. Verschuur	<u>Icarus</u> , 19, 329, 1973
403	Evidence for a Third Thermally Stable Phase of the Interstellar Gas	R. Giovanelli R. L. Brown	<u>Astrophys. J.</u> , 182, 755, 1973
404	Origin of Elements	L. E. Snyder D. Buhl B. Zuckerman	<u>Nature</u> , 242, 33, 1973
405	Observations of Further Outbursts in the Radio Galaxy 3C 120	K. I. Kellermann B. G. Clark D. L. Jauncey J. J. Broderick D. B. Shaffer M. H. Cohen A. E. Niell	<u>Astrophys. J.</u> , 183, L51, 1973
406	Interstellar Cloud Properties Revealed by Pulsars	R. M. Hjellming	Lenchek, A. M. (ed.), 1972, <u>The Physics of Pulsars</u> , (New York: Gordon and Breach), 69.
407	Wide Integrated Pulse Profiles of Pulsars	D. C. Backer V. Boriakoff R. N. Manchester	<u>Nature-Phys. Sci.</u> , 243, 77, 1973
408	Radio Stars AR Lacertae and Cygnus X-2	R. M. Hjellming L. C. Blankenship	<u>Nature-Phys. Sci.</u> , 243, 81, 1973
409	Precise Positions of Radio Sources. IV. Improved Solutions and Error Analysis for 59 Sources	P. Brosche C. M. Wade R. M. Hjellming	<u>Astrophys. J.</u> , 183, 805, 1973
410	Search for Solar Recombination Lines in the Frequency Range 110-115 GHz	F. I. Shimabukuro W. J. Wilson	<u>Astrophys. J.</u> , 183, 1025, 1973
411	Radio Recombination Lines and Dark Nebulae	M. A. Gordon	<u>Astrophys. J.</u> , 184, 77, 1973

No.	Title	Author	Reference
412	Carbon Monoxide and Hydrogen Cyanide Millimeter-wave Emission from Stars	W. J. Wilson P. R. Schwartz E. E. Epstein	<u>Astrophys. J.</u> , 183, 871, 1973
413	The Ionization of Dark Clouds: Implications from Searches for Radio Recombination Lines	R. L. Brown	<u>Astrophys. J.</u> , 184, 693, 1973
414	Spectra of Sources in the 5C Survey Regions	J. J. Condon D. L. Jauncey	<u>Astrophys. J.</u> , 184, L33, 1973
415	Radio Emission from Ceres	F. H. Briggs	<u>Astrophys. J.</u> , 184, 637, 1973
416	A Search for Interstellar Acrylon- itrile, Pyrimidine, and Pyridine	M. N. Simon M. Simon	<u>Astrophys. J.</u> , 184, 757, 1973
417	21-Centimeter Absorption at $z =$ 0.692 in the Quasar 3C 286	R. L. Brown M. S. Roberts	<u>Astrophys. J.</u> , 184, L7, 1973
418	Observations of Atmospheric Ozone at 110.836 GHz	F. I. Shimabukuro W. J. Wilson	<u>J. Geophys. Res.</u> , 78, 6136, 1973
419	Observations of OH and H ₂ CO Toward Galactic Dust Clouds	P. C. Myers	<u>Astrophys. J. Suppl.</u> <u>Ser.</u> , 26, 83, 1973
420	Millimeter Emission Lines of Polya- tomic Molecules in Sagittarius B2	P. M. Solomon A. A. Penzias K. B. Jefferts R. W. Wilson	<u>Astrophys. J.</u> , 185, L63, 1973
421	Very Long Baseline Interferometric Observations of the H ₂ O Sources in W49 N, W3(OH), Orion A, and VY Canis Majoris	J. M. Moran G. D. Papadopoulos B. F. Burke K. Y. Lo P. R. Schwartz D. L. Thacker K. J. Johnston S. H. Knowles A. C. Reisz I. I. Shapiro	<u>Astrophys. J.</u> , 185, 535, 1973
422	On the Isotopic Abundances in the Orion Nebula Molecular Cloud	L. E. Snyder D. Buhl	<u>Astrophys. J.</u> , 185, L79, 1973
423	Anomalous 1720-MHz OH Emission from V1057 Cygni	K. Y. Lo K. P. Bechis	<u>Astrophys. J.</u> , 185, L71, 1973
424	On the Source of the Slowly Varying Component at Centimeter and Milli- meter Wavelengths	F. I. Shimabukuro G. A. Chapman E. B. Mayfield S. Edelson	<u>Solar Phys.</u> , 30, 163, 1973

No.	Title	Author	Reference
425	Observations of the Recombination-Line Region Toward Sagittarius A	R. L. Brown B. Balick	<u>Astrophys. J.</u> , 185, 843, 1973
426	Detection of 21-centimeter Hydrogen Absorption in the High-Velocity Component of the Radio Galaxy Perseus A	D. S. De Young M. S. Roberts W. C. Saslaw	<u>Astrophys. J.</u> , 185, 809, 1973
427	HNCO in the Galactic Centre	D. Buhl L. E. Snyder P. R. Schwartz J. Edrich	<u>Nature</u> , 243, 513, 1973
428	High Resolution Radio Observations of Planetary Nebulae	M. A. Kaftan-Kassim	<u>Mem. Soc. Roy. Sci. Liege</u> , 5, 129, 1973
429	Radio Emission Nebulae Surrounding MWC 349 and RY Scuti	R. M. Hjellming L. C. Blankenship B. Balick	<u>Nature-Phys. Sci.</u> , 242, 84, 1973
430	Search for Radio Pulses from the Galactic Centre	R. Dube E. J. Groth L. Rudnick D. T. Wilkinson	<u>Nature-Phys. Sci.</u> , 245, 17, 1973
431	Interstellar Methylacetylene and Isocyanic Acid	L. E. Snyder D. Buhl	<u>Nature-Phys. Sci.</u> , 243, 45, 1973
432	Observations of Radio Emission of Clusters of Galaxies	H. M. Tovmassian	<u>Astrofizika</u> , 9, 177, 1973
433	Pulse Emission Mechanisms in Pulsars	R. N. Manchester E. Tademaru J. H. Taylor G. R. Huguenin	<u>Astrophys. J.</u> , 185, 951, 1973
434	A Prolonged Injection Model for Variable Radio Sources	F. W. Peterson W. A. Dent	<u>Astrophys. J.</u> , 186, 421, 1973
435	W3(OH): Accurate Relative Positions of Water-Vapor Emission Features	A. C. Reisz I. I. Shapiro J. M. Moran G. D. Papadopoulos B. F. Burke K. Y. Lo P. R. Schwartz	<u>Astrophys. J.</u> , 186, 537, 1973
436	Radio Source Counts and Cosmology	S. von Hoerner	<u>Astrophys. J.</u> , 186, 741, 1973
437	Interstellar Ammonia	M. Morris B. Zuckerman P. Palmer B. E. Turner	<u>Astrophys. J.</u> , 186, 501, 1973

No.	Title	Author	Reference
438	Interferometric Measurements of the Compact Source 2048 + 31	R. H. Becker M. R. Kundu	<u>Nature-Phys. Sci.</u> , 244, 138, 1973
439	Observations of the J = 2 to J = 1 Transition of Interstellar CO at 1.3 Millimeters	P. G. Phillips K. B. Jefferts P. G. Wannier	<u>Astrophys. J.</u> , 186, L19, 1973
440	Nonthermal OH Emission in Interstellar Dust Clouds. II.	B. E. Turner	<u>Astrophys. J.</u> , 186, 357, 1973
441	Neutral Hydrogen Observations of Eight Globular Clusters	G. R. Knapp W. K. Rose F. J. Kerr	<u>Astrophys. J.</u> , 186, 831, 1973
442	Polarization of Solar Active Regions at 3.5 Millimeter Wavelength	M. R. Kundu T. Gergely	<u>Solar Phys.</u> , 31, 461, 1973
443	Interstellar CS: Observations of New Transitions and Isotopic Species and a Study of its Excitation	B. E. Turner B. Zuckerman P. Palmer M. Morris	<u>Astrophys. J.</u> , 186, 123, 1973
444	A Radio Recombination Line in the Spectrum of W44	R. C. Bignell	<u>Astrophys. J.</u> , 186, 889, 1973
445	The 220 Å Extinction Feature and the Shape-Distribution of Graphite Grains	N. C. Wickramasinghe K. Nandy	<u>Astrophys. Space Sci.</u> , 26, 123, 1974
446	Fine Structure of a Solar Flare Region at 3.7 and 11.1 cm Wavelength	M. R. Kundu T. Velusamy R. H. Becker	<u>Solar Phys.</u> , 34, 217, 1974