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RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA.

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THE NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January 1 - March 31, 1985

INDEX

A. TELESCOPE USAGE

The NRAO telescopes have been scheduled for research and maintenance in the following manner during the first quarter of 1985.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1972.00	1925.00	1698.25	1663.2
Scheduled maintenance and equipment changes	111.00	122.75	82.50	268.8
Scheduled tests and calibrations	49.00	96.25	355.25	221.0
Time lost	278.25	66.75		
Actual observing	1693.75	1858.25	1287.25	1487.8

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer	Program
U19	J. Uson D. Wilkinson (Princeton)	Continue search at 19.5 GHz for small-scale anisotropy of the microwave background.
U20	J. Uson D. Wilkinson (Princeton)	Observations of the Sunyaev-Zeldovich effect at 19.5 GHz.

The following line programs were conducted during this quarter.

No.	Observer	Program
B421	R. Bachiller (Grenoble) J. Cernicharo (Grenoble)	Search at 1.3 cm for NH_3, HC_3N, and HC_5N in six dense fragments of the Perseus dark cloud.
B422	M. Bell (Herzberg) H. Matthews (Herzberg) T. Sears (Brookhaven)	Search at 1.5 cm for C_5H in TMC1 and an examination of IRC+10216 for HC_9N and C_5H.
B428	L. Blitz (Maryland) L. Armus (Maryland) V. Escalante-Ramirez (CFA) T. Hartquist (Maryland) S. Lepp (Maryland) T. Hewagama (Maryland)	Observations at 327 MHz to search for interstellar deuterium.

No.	Observer	Program
B429	R. D. Brown (Monash) P. Godfrey (Monash) S. Madden (Massachusetts)	Observations at 1.6 cm to search for ketenimine ($H_2C=C=NH$), a new interstellar molecule.
B431	W. Batrla	Observations at 1.2 cm to precisely determine the ^{15}N to ^{14}N ratio in the dark cloud L1544.
C222	F. Clark (Kentucky) S. Fulkerson (Centre College) S. Miller (Kentucky)	Study at 23.6945 GHz of cloud dynamics at different core ratios by the measurement of NH_3.
H200	A. Haschick (Haystack) J. Schmelz (Penn State)	Observations at 1.2 cm for extragalactic H_2O maser emission.
K293	H. Kroto (Sussex) L. Little (Kent) D. Macnaughton (Sussex) N. Matthews (Kent)	Search at 19 GHz for interstellar H_3C_5N in TMC1.
K294	H. Kroto (Sussex) L. Little (Kent)	Search at 18.5 GHz for interstellar cyanoacetylene.
M224	H. Matthews (Herzberg) T. Amano (Herzberg) P. Feldman (Herzberg) S. Saito (Inst. Mol. Sc., Japan)	Search at 1.3 cm for the radicals HCCN and CCN.
M227	H. Matthews (Herzberg) J. Caswell (CSIRO) R. Haynes (CSIRO) F. Olnon (Leiden) A. Winnberg (Chalmers) W. Batrla	Survey at 1.2 cm for H_2O maser sources in the galactic plane.
M235	P. Myers (CFA) A. Goodman (CFA) J. Moran (CFA) J. Torrelles (CFA)	Search at 1.3 cm for stellar outflow in the NH_3 line and search for dense cores near IRAS sources.
R207	R. Rood (Virginia) T. Bania (Boston) T. Wilson (MPIR, Bonn)	Observations at 8.7 GHz of the hyperfine transition of $^3He+$ in several galactic HII regions and planetary nebulae.
W192	A. H. Wootten R. Loren (Texas) L. Mundy (Caltech)	Search at 1.5 cm for symmetric top molecules CH_3C_6H and CH_3C_5N.

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

B - Effelsberg MPIR 100-m
C - Algonquin 150-ft
F - Fort Davis 85-ft
G - Green Bank 140-ft
H - Hat Creek 85-ft
I - Iowa 60-ft
Jb - Jodrell Bank Mk II
Jm - Jodrell Bank 120-ft
Km - Haystack 120-ft
Lm - Medicina 32-m
N - NRL Maryland Point 85-ft
O - Owens Valley 130-ft
Sn - Onsala 20-m
Yn - Socorro n=1-27x25 m

No.	Observer	Program
B59V	D. Backer (Berkeley) C. Masson (Caltech) A. Moffet (Caltech) J. Moran (CFA) T. Pearson (Caltech) R. Plambeck (Caltech) C. R. Predmore (Massachusetts) A. Readhead (Caltech) A. Rogers (Haystack) M. Wright (Berkeley)	Observations at 1.3 cm to study the structure of the compact nucleus in the core of NGC 1275, with telescopes B, G, Km, N, O, Sn, and Yn.
B63V	N. Bartel (CFA)	Observations at 6 cm of SN 1979c, with telescopes B, G, O, and Yn.
D9V	P. Diamond (MPIR, Bonn) J. Chapman (Manchester) K. Johnston (NRL)	Monitoring at 1.3 cm of H_2O masers around the supergiant S Per, with telescopes B, G, Km, N, O, Sn, and Yn.
E9V	A. Eckart (MPIR, Bonn) P. Biermann (MPIR, Bonn) K. Johnston (NRL) C. Schalinski (MPIR, Bonn) A. Witzel (MPIR, Bonn)	Observations at 1.3 cm to investigate the submilliarcsecond structure of the quasar 1928+73, with telescopes B, G, Km, O, and Sn.
H14V	D. Hough (Caltech) A. Readhead (Caltech)	Observations at 1.3 cm of the central components of the double-lobed quasars 3C 207, 3C 212 and 3C 245, with telescopes B, G, H, O, Sn, and Yn.
J37V	K. Johnston (NRL) R. Booth (Chalmers) P. Bowers (NRL) R. Cohen (Manchester) P. Diamond (MPIR, Bonn) J. Spencer (NRL) A. Lane	Observations at 1.3 cm to study the emission from H_2O masers associated with late-type stars, with telescopes B, G, N, O, Sn, and Yn.

No.	Observer(s)	Program
L32V	C. Lawrence (Caltech) R. Linfield (JPL) A. Readhead (Caltech) R. Schilizzi (NFRA)	Mapping at 1.3 cm of sources selected from a survey at this wavelength, with telescopes B, G, Jb, Km, Lm, O, Sn, and Yn.
M60V	L. Molnar (CFA) J. Grindlay (CFA) M. Reid (CFA)	Observations at 1.3 cm to study the expansion of Cygnus X-3, with telescopes B, G, Km, O, and Yn.
R33V	D. Roberts (Brandeis) L. Brown (Brandeis) B. Burke (MIT) D. Gabuzda (Brandeis) R. Potash (Interferometerics) A. Rogers (Haystack) J. Wardle (Brandeis)	Observations at 6 cm to survey and monitor selected sources for linear polarization, with telescopes B, F, G, Km, O, and Yn.
R34V	R. Rusk (Toronto) E. Seaquist (Toronto) J. Yen (Toronto)	Observations at 1.3 cm of sources with well-studied optical polarization properties with telescopes B, C, G, Km, O, and Yn.
S45V	S. Spangler (Iowa) J. Cordes (Cornell) D. Morris (Iowa) R. Mutel (Iowa) J. Benson	Observations at 6 cm for cosmic ray induced turbulence near supernova remnants with telescopes B, G, I, O, and Yn.
W23V	R. C. Walker S. Unwin (Caltech J. Benson G. Seielstad	Continued monitoring at 6 cm of 3C 120, with telescopes B, F, G, H, I, Km, O, Sn, and Yn.
W39V	A. Witzel (MPIR, Bonn) P. Biermann (MPIR, Bonn) A. Eckart (MPIR, Bonn) C. Schalinski (MPIR, Bonn) R. Simon (NRL)	Observations at 1.3 cm of the submilli-arcsecond structure of a complete sample of extragalactic radio sources, with telescopes B, G, Jm, Km, Lm, O, Sn, and Yn.
X31V	J. Marcaide (MPIR, Bonn) B. Corey (Haystack) N. Kardashev (IFSR, USSR) K. Pogrebienko (IFSR, USSR) M. Popov (IFSR, USSR)	Monitoring at 1.3 cm of the compact source in Sgr A with telescopes G, Km, and O.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A59	H. Aller (Michigan) M. Aller (Michigan) R. Fanti (Michigan) A. Ficarra (Bologna) F. Mantovani (Bologna) L. Padrielli (Bologna)	Observations at 1400 and 2695 MHz of low-frequency variable sources selected from the Bologna-Michigan Program.
B412	B. Burke (MIT) J. Hewitt (MIT) G. Langston (MIT) J. Mahoney (MIT)	Observations at 6 cm to continue the MIT-Green Bank survey at $\delta = 20°$ $< \delta < 45°$.
E43	W. Erickson (Maryland) S. Ananthakrishnan (Tata) D. Bagri (Tata) H. Cane (Maryland)	Observations over the range of 100-300 MHz to study polarization and flux of low-frequency variable sources.
O32	C. O'Dea T. Balonek (Williams College) W. Dent (Massachusetts) W. Kinzel (Massachusetts)	Polarization and flux density measurements of variable sources at 2695 MHz.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
G271	R. Giovanelli (NAIC) M. Haynes (Cornell) C. Magri (Cornell)	Observations of neutral hydrogen in galaxies found in clusters and superclusters.
H195	M. Haynes (Cornell) R. Giovanelli (NAIC)	Search for HI near isolated and group galaxies.
R214	O. Richter (STScI) W. Huchtmeier (MPIR, Bonn) J. Materne (Tech. U. Berlin)	Observations of the HI spectra of galaxies lying between Virgo and the Hydra/Centaurus supercluster.
W194	A. H. Wootten J. Armstrong	Observations of neutral hydrogen to investigate the gas content of dusty galaxies.

The following pulsar program was conducted during this quarter.

No.	Observer	Program
T178	J. Taylor (Princeton) R. Dewey (Cornell) G. Stokes (Princeton) J. Weisberg (Princeton)	Continuation of the northern hemisphere pulsar survey at 390 MHz.

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer	Program
B411	A. Barrett (MIT) J. Jackson (MIT) P. Ho (Harvard)	CO survey of star-burst galaxies.
B419	A. Barrett (MIT) J. Jackson (MIT)	Study of CO in the Seyfert galaxies NGC 1068 and NGC 4051.
B426	J. Black (Arizona)	Study of molecular oxygen in OH/IR stars.
B427	L. Blitz (Maryland) R. Mathieu (Harvard)	CO (J=2-1) observations of M31 and M33.
B433	R. Brown	Study of CII regions in molecular clouds.
B434	R. Brown	Study of kinematics of ionized gas at the galactic center.
E45	N. Evans (Texas) S. Beckwith (Cornell)	Study of CO (J=2-1) towards evolved stars with OH masers.
G276	M. Gordon P. Jewell C. Salter	A study of dust emission from Orion A and other HII regions.
G278	M. Gordon	Study of millimeter-wave recombination lines from galactic HII regions.
H197	P. Ho (Harvard) J. Turner (Harvard) R. Martin (IRAM)	2-1 CO study of three nearby spiral galaxies.

No.	Observer	Program
H202	P. Huggins (New York) A. Healy (New York)	Studies of CO (2-1) circumstellar envelopes.
H203	P. Huggins (New York) A. Healy (New York)	Study of the SiO, SiS, and CR in IRC+10216.
K283	T. Kuiper (JPL) E. Kuiper (JPL) B. Zuckerman (UCLA)	Study of high velocity outflows in Orion.
K285	M. Kutner (Rensselaer) K. Mead (Rensselaer)	High resolution maps of clouds in the outer galaxy.
L175	H. Liszt	Study of CO (J=2-1) from NGC 1068.
L187	E. Lellouch (Meudon) T. Encrenaz (Meudon) R. Courtin (Meudon)	Search for HCN on Jupiter, Saturn, and Titan.
L193	C. Lada (Arizona) M. Margulis (Arizona) E. Young (Arizona) B. Wilking (Missouri)	Search for energetic outflows in Ophiuchus.
M211	D. Backer (Berkeley)	89 GHz VLBI.
M212	D. Muhleman (Caltech) T. Clancey (Colorado) G. Berge (Caltech)	Measurement of the $12^C/13^C$ ratio in the Venusian atmosphere.
R216	L. Rickard (Howard) B. Turner P. Palmer (Chicago)	Study of CO J=2-1 emission from galaxies.
S265	P. Schwartz (NRL)	Study of $C_{18}O$ (J=2-1) in bipolar flows.
S266	A. Sandqvist (Stockholm) A. H. Wootten R. Loren (Texas)	Study of shocked gas and ionization of Srr A. West.
S273	A. Sandqvist (Stockholm) T. Elfhag (Stockholm) J. Joersaeter (Stockholm) P. Lindblad (Sweden)	Search for 1-mm and 3-mm CO lines in NGC 1365.

No.	Observer	Program
S277	F. Kerr (Maryland) C. Salter R. Sinha (SASC, Maryland) R. Hobbs (Computer Tech Assoc.) E. Stobie	90 and 230 GHz observations of the galactic center.
V44	F. Verter (Rensselaer)	CO (J=2-1) studies of M31.
V51	F. Verter (Rensselaer) M. Kutner (Rensselaer)	Proposal to complete a study of the arm-interarm contrast in M51.
W178	A. H. Wootten	Observations of the J=3-2 line of xogen in molecular outflow regions.
W182	P. Wannier (JPL) R. Sahai (Caltech) R. Sahai (Caltech)	Study of isotope abundances in carbon-rich stars.
W190	G. Wolf (Arizona) C. Lada (Arizona)	Study of density structures in high velocity molecular outflows.
Z44	L. Ziurys (Berkeley) R. Saykally (Berkeley) B. Turner M. Kutner (Rensselaer)	Study of vibrationally-excited HCN and HNC.

E. VLA OBSERVING PROGRAMS

No.	Observer	Program
AA-41	R. Antonucci E. Olszewski (DAO) P. Hickson (British Columbia) J. Miller (Lick Obs.)	A new sample of BL Lac objects. 20 cm.
AB-129	B. Burke (Caltech/MIT) J. Hewitt (MIT) D. Roberts (Brandeis)	Monitoring 0957+561. 6 cm.
AB-182	J. Burns (New Mexico) T. Balonek (Williams Col.) E. Hummel (MPIR, FRG)	Monitoring the cores of extended radio sources and spiral galaxies. 2, 6 and 21 cm.

No.	Observer	Program
AB-248	D. Backer (Berkeley) R. Sramek	Astrometric observations of the compact source in Sagittarius A. 2, 6 and 18 cm.
AB-306	J. Basart (Iowa) J. Burns (New Mexico) D. De Young (NOAO)	Jets in classical doubles: 3C 47 and 0110+297. 20 cm.
AB-307	C. Benn (MRAO) J. Wall (RGO) G. Grueff (Bologna) M. Vigotti (Bologna)	5C 12 sources. 6 cm.
AB-312	W. Baan (Arecibo) A. Haschick (Haystack) J. Schmelz (Penn State)	OH and HI in NGC 3690. 18 and 20-cm line.
AB-313	R. Becker (Calif., Davis) D. Helfand (Columbia)	Fine structure within 2 galactic SNR. 20 cm.
AB-315	J. Biretta (Caltech) F. Owen T. Cornwell P. Hardee (Alabama)	Proper motion and structure of M87 jet. 2, 18 and 20 cm.
AB-317	T. Bastian (Colorado) G. Dulk (Colorado) O. Slee (CSIRO)	Flare stars in stellar associations 6 and 20 cm.
AB-319	P. Bowers (NRL) G. Knapp (Princeton)	Search for protoplanetary nebulae associated with OH/IR stars (Part I). 18-cm line.
AB-321	I. Browne (Jodrell Bank) T. Muxlow (Jodrell Bank) F. Mantovani (Bologna) L. Padrielli (Bologna)	Multiple hotspots and tails in 3C 159. 6 and 18 cm.
AB-322	P. Barthel (Caltech) C. Lonsdale (Penn State) G. Miley (STScI/Leiden) R. Schilizzi (NFRA)	High redshift quasars. 2 and 6 cm.
AB-323	I. Browne (Jodrell Bank) T. Boroson (Michigan)	An optical/radio test of relativistic beaming models. 6 cm.

No.	Observer	Program
AB-324	C. Blaha (Minnesota) J. Pedelty (Minnesota) J. Dickey (Minnesota) R. Kennicutt (Minnesota)	"Hot Spot" nuclei. 2, 6 and 20 cm.
AB-325	J. Bieging (Berkeley) M. Cohen (NASA-Ames)	Flux density and spectral index monitoring of V410 Tau. 2 and 6 cm.
AB-326	J. Bieging (Berkeley)	Rapid rotators in the Pleiades. 6 cm.
AB-327	J. Bieging (Berkeley) E. Churchwell (Wisconsin) D. Abbott (Colorado)	Stellar wind temperature determination by visibility measurements for two early-type stars. 2 and 6 cm.
AB-328	J. Bieging (Berkeley) M. Cohen (NASA-Ames)	Jets in T Tauri stars. 6 cm.
AB-329	W. Baan (Arecibo) A. Haschick (Haystack) J. Schmelz (Penn State)	Intense water maser source in NGC 3079. 1.3-cm line.
AC-91	J. Cordes (Cornell) J. Weisberg (Princeton) T. Hankins (Dartmouth)	Pulsar dynamic spectra and waveforms and neutron star velocities. 20-cm line.
AC-108	P. Coleman (Pittsburgh) J. Condon	Angular-size distribution of a new population of faint extragalactic sources. 20-cm line.
AC-114	B. Clark R. Perley	High resolution source structure survey. 2 and 6 cm.
AC-115	S. Catalano (Catania) D. Gibson (NMIMT) M. Rodono (Catania)	Flux and luminosity limited surveys of Algol binaries. 6 cm.
AC-116	E. Churchwell (Wisconsin) D. Abbott (Colorado) J. Bieging (Berkeley)	Monitoring a new class of stellar nonthermal emitters. 2, 6, and 20 cm.
AC-119	G. Chanmugam (Louisiana State) G. Dulk (Colorado) T. Bastian (Colorado)	Magnetized cataclysmic variables. 2, 6, and 20 cm.

No.	Observer	Program
AC-120	R. Conway (Jodrell Bank) R. Davis (Jodrell Bank) C. Flatters (Jodrell Bank) R. Perley	Polarization observations of 3C 273, 3C 345 and 3C 454.3. 6 and 18 cm.
AC-121	P. Crane R. Price (New Mexico)	The radio nucleus of M81. 2, 6 and 20 cm.
AC-122	P. Crane J. van der Hulst (NFRA) H. Ford (STScI) D. Lawrie (Ohio State) G. Jacoby (NOAO)	Nuclear region of M51. 6 cm.
AC-125	W. Christiansen (N. Carolina) J. Stocke (Steward) C. Foltz (Steward)	Search for environmental effects on radio galaxies. 6 and 20 cm.
AC-126	J. Cordes (Cornell) R. Dewey (Cornell)	Proper motion study of pulsars showing high scintillation speeds. 20 cm.
AC-127	M. Cohen (NASA-Ames) J. Bieging (Berkeley)	Search for extended structure associated with active pre-main-sequence stars. 6 cm.
AC-128	R. Cameron (Mt. Stromlo) G. Bicknell (Mt. Stromlo) R. Ekers	Jet radio sources in southern clusters 2104-25. 6, 18 and 21 cm.
AC-129	J. Cox (NMIMT) D. Gibson (NMIMT)	Chi 1 Orionis. 2, 6 and 20 cm.
AD-140	A. Downes (Cambridge) S. Gull (Cambridge) S. Tan (Cambridge)	First epoch observations of the young SNR G11.2-0.3. 6 and 20 cm.
AD-141	S. Drake (Colorado) J. Linsky (Colorado)	Chromospheric radio emission and temperatures in nearby cool giant stars. 2 and 6 cm.
AD-142	J. Dickel (Illinois) K. Long (Johns Hopkins) Y. Matsui (Johns Hopkins) E. Greisen	Second epoch observations of Kepler's SNR. 6 and 20 cm.
AD-147	P. Diamond (MPIR, Bonn) L. Nyman (Onsala)	OH and H_2O maser emission in W43(OH). 1.3, 6 and 18-cm line.

No.	Observer	Program
AD-149	H. Dickel (Illinois) W. M. Goss (Groningen) A. Rots	H_2CO absorption at 2-cm towards W 58 C1 (ON 3). 2-cm line.
AD-154	S. Drake (Colorado) D. Florkowski (USNO) F. Walter (Colorado) J. Linsky (Colorado)	FK Comae stars. 2, 6 and 18 cm.
AD-155	P. Diamond (MPIR, Bonn) K. Johnston (NRL) J. Chapman (Jodrell Bank)	Global array monitoring of the H2O masers around the supergiant S Per. 1.3-cm line.
AD-156	S. Drake (Colorado) E. Churchwell (Wisconsin) J. Linsky (Colorado)	Bp stars. 2, 6 and 18 cm.
AD-157	L. Dressel (Rice)	Extended nuclear radio sources in SO galaxies. 6 and 20 cm.
AD-158	J. Dreher (MIT) R. Laing (RGO)	Hotspots in nearby radio sources. 2 cm.
AE-40	D. Emerson (IRAM) T. Forveille (IRAM) L. Weliachew (IRAM)	The compact HII region in CEP A: flux measurements. 1.3, 2 and 6 cm.
AF-84	M. Felli (Arcetri) M. Simon (Stonybrook)	Resolution of radio emission of circumstellar ionized regions. 1.3 cm.
AF-92	E. Feigelson (Penn State) B. Geldzahler (NRL) K. Johnston (NRL)	Coordinated radio, optical, ultraviolet and X-ray observations of the BL Lac object H0323+022. 2, 6, and 20 cm.
AF-95	J. Fix (Iowa) M. Cobb (Iowa)	Spectral line maps of OH1.1-0.8. 18-cm line.
AF-97	E. Fomalont B. Geldzahler (NRL)	Sco X-1. 6 and 20 cm.
AG-116	D. Gibson (NMIMT) W. Priedhorsky (LANL)	Monitoring Cyg X-1. 2, 6 and 20 cm.
AG-154	R. Gaume (Iowa) R. Mutel (Iowa)	The main line and 1720 MHz satellite line emission toward star formation regions. 18-cm line.

No.	Observer	Program
AG-155	R. Gaume (Iowa) R. Mutel (Iowa)	The 1720 MHz hydroxyl emission toward supernova remnants. 18-cm line.
AG-162	G. Giovannini (Bologna) L. Feretti (Bologna) L. Gregorini (Bologna) P. Parma (Bologna) G. Zamorani (Bologna)	Elliptical radio galaxies with undetected core radio emission. 6 cm.
AG-164	A. Gower (Victoria) J. Hutchings (DAO)	Low redshift quasars. 1.3 and 2 cm.
AG-167	P. Gregory (British Columbia) A. Taylor (Toronto)	Short-term variable sources in the galactic plane. 6 and 20 cm.
AG-170	J. Greenberg (Leiden) J. Roland (Leiden) N. Brosch (Wise)	Radio sources near NGC 2264. 20 cm.
AG-171	G. Giovannini (Bologna) L. Feretti (Bologna)	New wide angle tail radio source associated with NGC 4874. 6 and 20 cm.
AG-174	S. Guilloteau (Grenoble) W. M. Goss (Groningen) A. Baudry (Bordeaux, France) H. Matthews (Herzberg) T. Forveille (Grenoble)	Six centimeter formaldehyde in G10.6-0.4. 6-cm line.
AG-177	G. Garay (ESO, FRG) J. Moran (CFA) M. Reid (CFA) L. Rodriguez (Mexico)	Monitoring theta 1 Orionis. 2, 6 and 20 cm.
AH-143	E. Hummel (MPIR, Bonn) J. van der Hulst (NFRA) R. Sramek	Monitoring star burst galaxies to search for supernovae. 6 cm.
AH-167	J. Hewitt (MIT) C. Bennett (MIT) B. Burke (MIT) C. Lawrence (Caltech) E. Turner (Princeton)	Search for gravitational lenses. 6 cm.
AH-170	P. Hintzen (NASA-GSFC) F. Owen	Distorted radio QSOs. 6 and 20 cm.

No.	Observer	Program
AH-171	P. Hintzen (NASA/GSFC) F. Owen	Snapshot survey of radio QSOs to identify distorted sources. 20 cm.
AH-172	R. Hjellming K. Johnston (NRL)	Mapping of SS433. 2 and 6 cm.
AH-174	J. M. Hollis (NASA-GSFC) A. Michalitsianos (NASA-GSFC) M. Kafatos (George Mason)	Flux variations and structure in RX Puppis. 2 cm.
AH-177	J. Hutchings (DAO) A. Gower (Victoria)	A comparison of low and intermediate redshift quasars. 6 and 20 cm.
AH-181	J. Hutchings (DAO) A. Gower (Victoria) J. van Gorkom R. Sramek	Twenty-one centimeter absorption in quasars and active galaxies. 20-cm line.
AH-182	D. Hogg	Search for the stellar winds from the nuclei of planetary nebulae. 6 cm.
AH-185	G. Hennessy (NMIMT)	Monitoring Nova Vulpeculae. 2 cm.
AH-195	R. Hjellming R. Davis (Jodrell Bank)	Nova RS Ophiuchi. 1.3, 2, 6, and 20 cm.
AJ-104	K. Johnston (NRL) D. Florkowski (USNO) C. Wade G. Gatewood (Pittsburgh) C. de Vegt (Hamb. Stern., FRG) M. Shao (NRL)	Optical/radio positions of the stars Algol, HR1099 and UX Ari. 6 cm.
AJ-120	K. Johnston (NRL) C. Wade P. Seidelman (USNO) G. Kaplan (USNO) I. Nolt (Oregon) I. Robson (UKIRT, UK) G. Veeder (JPL) W. Webster (NASA-GSFC)	Multispectral observations of the minor planet Vesta. 2 and 6 cm.
AJ-121	K. Johnston (NRL) D. Florkowski (USNO) C. Wade C. de Vegt (Hamb. Stern., FRG)	Relationship of radio and optical reference frames. 6 cm.

No.	Observer	Program
AJ-122	K. Johnston (NRL) P. Bowers (NRL) J. Spencer (NRL) P. Diamond (Onsala) C. de Vegt (Hamb. Stern., FRG) A. Lane	Optical/radio positions of OH maser stars. 18-cm line.
AJ-123	K. Johnston (NRL) J. Spencer (NRL) P. Bowers (NRL) A. Lane R. Booth (Onsala) P. Diamond (Onsala) R. Cohen (Manchester)	Water maser emission from late-type stars. 1.3-cm line.
AK-113	S. Kwok (Calgary)	Survey of compact planetary nebulae. nebulae. 2 and 6 cm.
AK-114	P. Katgert (Leiden) M. Oort (Leiden) R. Windhorst (Mt. Wilson)	Morphology-luminosity correlation at high (greater than 0.3) redshifts. 20 cm.
AK-117	M. Kundu (Maryland) R. Shevgaonkar (Maryland) G. Hurford (Caltech) D. Gary (Caltech) G. Dulk (Colorado) T. Bastian (Colorado) K. Lang (Tufts) R. Willson (Tufts)	Solar hard X-ray microbursts. 20 cm.
AK-119	W. Kailey (Arizona) R. Elston (Arizona)	Search for supernova remnants near the nucleus of M33. 20 cm.
AK-120	W. Keel (NOAO)	PKS 0521-36 jet. 2 cm.
AK-121	W. Kollatschny (Gottingen) K. Fricke (Gottingen) W. Huchtmeier (MPIR, FRG)	Radio morphology of multiple nucleus galaxies. 6 and 20 cm.
AK-122	M. Kundu (Maryland) P. Shevgaonkar (Maryland) P. Jackson (Maryland)	Selected late-type stars. 2, 6 and 20 cm.
AK-124	P. Kronberg (Toronto) R. Sramek	Monitoring M82. 2 and 6 cm.
AL-93	C. Lonsdale (Penn State) P. Barthel (Leiden)	High redshift quasars. 2 cm.

No.	Observer	Program
AM-124	I. McHardy (Leicester) R. Warwick (Leicester) A. Smith (ESTEC)	Coordinated radio, optical and X-ray observations of optically, violently variable extragalactic radio sources and BL Lacertae objects. 2, 6 and 20 cm.
AM-135	R. Mutel (Iowa) J. Lestrade (B. de Long, FR)	RS CVn binaries: Correlation with period. 2, 6 and 20 cm.
AM-139	G. Miley (STScI/Leiden) R. de Grijp (Leiden)	Study of infrared AGN candidates. 6 and 20 cm.
AM-141	G. Miley (STScI/Leiden) A. Bridle T. Heckman (Maryland) R. Laing (RGO) F. Macchetto (STScI) W. van Breugel (Berkeley)	Jets and hot spots for Space Telescope. 2 and 6 cm.
AM-142	T. Montmerle (CEN Saclay, FR) E. Feigelson (Penn State)	Pre-main sequence stars in the rho Ophuichi cloud. 2, 6 and 20 cm.
AM-143	J. Moran (CFA) G. Garay (ESO, FRG) M. Reid (CFA) R. Genzel (Berkeley)	IRc2 and BN in Orion KL. 1.3, 2 and 6 cm.
AM-145	K. Mitchell (VPI)	Accurate radio morphologies of a sample of faint radio selected quasars. 2 and 20 cm.
AM-146	A. Michalitsianos (NASA/GSFC) J. M. Hollis (NASA/GSFC) M. Kafatos (George Mason)	R Aquarii: Structure of the wind the LPV. 2 cm.
AN-28	R. Norris (CSIRO) K. Johnston (NRL) R. Simon (NRL)	OH masers associated with Orion IRc2. 18-cm line.
AN-33	L. Noreau (Toronto) P. Kronberg (Toronto)	Mapping of the nuclear region of NGC 3448. 2 and 6 cm.
AO-58	M. Oort (Leiden) P. Katgert (Leiden) R. Windhorst (Mt. Wilson)	Angular sizes and morphology of very weak radio galaxies. 20 cm.

No.	Observer	Program
AO-59	C. O'Dea R. Barvainis T. Balonek (Williams College)	Subarcsecond structure and polarization of core dominated radio sources. 1.3, 2 and 6 cm.
AP-92	M. Perryman (ESA) S. Alighieri, (Padova) F. Macchetto (STScI)	Gravitational interaction between the quasar MR 2251-178 and an active cluster galaxy. 20 cm.
AP-93	G. Pettengill (MIT) B. Chapman (MIT)	Radio emissivity of the surface of Venus. 20 cm.
AP-94	P. Parma (Bologna) H. de Ruiter (Bologna) C. Fanti (Bologna) R. Fanti (Bologna) R. Ekers	B2 0755+37. 6, 18 and 21 cm.
AP-96	J. Pedelty (Minnesota) L. Rudnick (Minnesota)	Properties of nuclear cores. 6 and 20 cm.
AP-97	J. Pedelty (Minnesota) L. Rudnick (Minnesota)	Relic pre-hotspot emission in 3C 295? 20 cm.
AR-116	R. Rusk (Toronto) E. Seaquist (Toronto) A. Yen (Toronto)	Brightness and polarization structure of sources with published VLBI structural position angles. 2, 6 and 18 cm.
AR-117	L. Rodriguez (Mexico) J. Garcia-Barreto (Mexico) Y. Gomez (Mexico)	HI absorption features in NGC 6302 and NGC 2440. 20-cm line.
AR-119	A. Rao (TIFR, India) R. Subrahmanyan (TIFR, India)	Double source showing peaked spectrum. 1.3, 2 and 6 cm.
AR-120	M. Reid (CFA) P. Ho (CFA)	Cometary HII regions. 20 cm.
AR-121	L. Rodriguez (Mexico) J. Canto (Mexico)	Search for triple structure in continuum sources associated with bipolar outflows. 2 cm.
AR-123	L. Rudnick (Minnesota) J. Pedelty (Minnesota) H. Spinrad (Berkeley)	Extended emission line systems in distant galaxies. 20 cm.

No.	Observer	Program
AR-124	D. Rudy (Caltech) D. Muhleman (Caltech) G. Berge (Caltech)	Mars: Latitude distribution of subsurface temperatures and radial distribution of linear polarization of the Southern Hemisphere. 2 and 6 cm.
AR-125	L. Rodriguez (Mexico) J. Garcia-Barreto (Mexico) Y. Gomez (Mexico)	Search for continuum emission from possible protoplanetary nebulae. 2 and 6 cm.
AS-79	S. Spangler (Iowa) W. Cotton S. Allendorf (Iowa)	Monitoring low frequency variables. 1.3, 2, 6 and 20 cm.
AS-80	R. Sramek J. van der Hulst (NFRA) K. Weiler (NSF)	Monitoring supernovae SN 1980 in NGC 6946 and SN 1979c in M 100. 6 and 20 cm.
AS-189	R. Strom (Dwingeloo)	Flat spectrum component in CTB80. 20 cm.
AS-211	R. Sramek K. Weiler (NSF) J. van der Hulst (NFRA) N. Panagia (STScI)	Statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-212	D. Saikia (TIFR, India) P. Shastri (TIFR, India) T. Cornwell C. Salter	Linear polarization observations of cores in quasars. 2, 6 and 20 cm.
AS-213	D. Saikia (TIFR, India) V. Kapahi (TIFR, India) T. Cornwell	Steep-spectrum cores--a study of cosmological implications and statistical properties. 6 and 20 cm.
AS-216	D. Shone (Jodrell Bank) D. Walsh (Jodrell Bank)	Compact high-redshift quasars. 2 cm.
AS-218	D. Shone (Jodrell Bank) I. Brown (Jodrell Bank) D. Walsh (Jodrell Bank) L. Rudnick (Minnesota) J. Pedelty (Minnesota)	The jet in 0800+608. 2 and 6 cm.
AT-55	A. Taylor (Toronto) E. Seaquist (Toronto) S. Kenyon (CFA)	Radio spectra of symbiotic stars. 1.3, 2 and 6 cm.

No.	Observer	Program
AT-58	R. Tufts (MPIR, Bonn) P. Angerhofer (USNO) M. Brown (Cambridge) S. Gull (Cambridge) R. Perley	Structure and secular change within Cassiopeia A at high spatial and temporal resolutions-second epoch. 6 and 20 cm.
AV-88	W. van Breugel (Berkeley) T. Foley (Leiden) G. Miley (STScI/Leiden) T. Heckman (Maryland) M. Ulrich (ESO, FRG)	Equatorial survey of radio galaxies. 20 cm.
AV-96	J. van der Hulst (NFRA) R. Sramek K. Weiler (NSF)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-116	P. Veron (ESO, FRG) J. Roland (IAP, France)	The reacceleration of particles in the turbulent wake of galaxies. 6 and 20 cm.
AV-117	P. Veron (ESO, FRG) J. Roland (IAP, France)	Compact radio sources with very steep radio spectra (α = 1.4). 6 and 20 cm.
AW-48	C. Wade K. Johnston (NRL) P. Seidelmann (USNO) G. Kaplan (USNO)	Astrometric observations of minor planets. 6 cm.
AW-78	J. Wardle (Brandeis) R. Laing (RGO)	Variability of the central components of extended radio sources. 2 and 6 cm.
AW-95	A. Winnberg (Onsala) B. Baud (Groningen) H. Habing (Leiden) F. Olnon (Leiden) H. Matthews (NRC)	Survey for OH/IR stars close to the galactic center. 18-cm line.
AW-123	M. Walmsley (MPIR, Bonn) W. Batrla D. Engels (MPIR, Bonn)	Peculiar water masers associated with IRAS sources. 1.3-cm line.
AW-124	R. White (STScI) R. Becker (Calif., Davis)	Resolution of stellar wind radio sources. 2, 6 and 20 cm.
AW-126	A. Wilson (Maryland) J. Ulvestad (JPL)	A distance limited sample of Seyfert galaxies. 6 and 20 cm.

No.	Observer	Program
AW-127	R. Windhorst (Mt. Wilson) M. Oort (Leiden) P. Katgert (Leiden)	Identifications of milli-Jansky sources in ultradeep optical fields. 20 cm.
AW-128	D. Walsh (NRAL) P. Tomasi (Bologna)	Optically faint steep spectrum sources. 6 and 20 cm.
AW-131	G. Wynn-Williams (Hawaii) C. Beichman (JPL) G. Miley (STScI/Leiden)	The double-lobed spiral galaxy IRAS 0421+040P06. 6 and 20 cm.
AW-132	A. Wehrle (UCLA) R. Ekers	Nuclear region of NGC 4631. 6 cm.
AY-7	F. Yusef-Zadeh (Columbia) M. Morris (UCLA)	Continuum arc near the galactic center. 20 cm.
AZ-25	E. Zukowski (Toronto) P. Kronberg (Toronto)	Strong extended radio sources which exhibit peculiar integrated polarization curves. 18 and 22 cm.

F. SCIENTIFIC HIGHLIGHTS

New Binary Pulsar

The extensive pulsar survey being carried out by the Princeton pulsar group with the Green Bank 300-ft telescope has yielded much valuable information on the distribution of faint, previously undetected pulsars. Their most recent discovery, however, has been the detection of another binary pulsar to complement the four that were known previously. The new binary pulsar has a period of 12.4 days and differs significantly from the other four in the extreme ellipticity of its orbit. It is suspected that the pulsar's companion must also be a compact object since a normal star would have produced sufficient tidal force on the pulsar's orbit to have circularized it long ago. Actually, the precession of the equinoxes which should be as large as 0.01 arcsecond per year will be observationally verifiable in another year or two, and the masses of both members of the binary pair will be determinant.

Circumstellar Shells

Recent observations of the circumstellar envelopes of late-type stars with the 12-m telescope promise to add significantly to the database of information available on the physical conditions in these objects. The high-frequency efficiency of the resurfaced 12-m, combined with the sensitivity of the improved 1-mm receiver, have greatly improved the detection rate of molecular shells surrounding stars by means of the CO J=2-1 spectral line. These shells provide ideal laboratories for studying

the physical characteristics of the mass-losing stages of stellar evolution. The 12-m observations measure mass loss rates, isotopic abundance ratios, molecular abundance ratios and, when combined with infrared observations, dust-to-gas ratios. For carbon-rich, mass-losing stars in particular, only mm-wave observations are likely to yield abundance measurements. CNO isotope abundance ratio determinations for these objects can potentially add much to our understanding of how material processed deep in the stellar core finds its way to the extended envelopes of giant stars. In addition, this class of object is a major contributor to the content of the interstellar medium and must significantly affect the observed cosmic abundances of the CNO nuclides.

CO in M51

Several investigators have been taking advantage of the powerful combination of the 1-mm receiver and the resurfaced 12-m telescope to map external galaxies in the 230 GHz line of CO (J=2-1). Investigators from RPI, in particular, have continued to sample the arm-interarm regions in the nearby face-on spiral galaxy M51. Their goal has been to make a more fully-sampled map of a small portion of the galaxy so as to compare the arm-interarm contrast of CO emission with theoretical models and with observations of other tracers of star formation. M51 has been well-studied at many wavelengths and has often been cited as a confirmation of the density wave theory of spiral arms. To date, however, no information has been available to evaluate how well the molecular component of the interstellar medium conforms to the density wave scenario in M51 or any galaxy, including the Milky Way. The current observations have now shown the CO does indeed concentrate to the inside of the spiral arms exactly as predicted by the density wave theory. Ultimately their observations will constrain density wave models of M51 since the observed enhancement of CO compared to the young star population is an indication of the required efficiency of shock-induced cloud collapse and star formation.

Energy Source for HH1 and HH2

Recent VLA observations of the Herbig-Haro objects HH1 and HH2 have detected the stellar wind source of energy which appears to be remotely powering the nebular objects. The source which is centrally located between HH1 and HH2 was detected in the continuum wavebands of 20, 6, and 2 cm. Optically invisible in even the deepest optical images of the region, the source is hypothesized to be surrounded by a donut-shaped envelope of gas and dust which is opaque to light but transparent to radio waves. The mechanism which collimates the flow of stellar wind particles into two antiparallel streams is still poorly understood.

Quasar Jet

The VLA has shown the steep spectrum quasar, 0800+608, to contain a very structurally detailed jet which has the potential to reveal much of the physics of energy transport in radio sources. Multiple VLA configuration images of the quasar jet show eleven individual knots with ordered separation strung out along a slightly curving arc emanating from the quasar

nucleus. Superposed on the jet curvature are wiggles whose wavelength and regularity are possibly caused by the pinching and helical modes of the Kelvin-Helmholtz instability. The most recent A and B configuration observations were designed for very high sensitivity to study the apparent cocoon surrounding the jet as well as for extremely high resolution to improve the positional accuracy of the knots and to provide the necessary detail which can ultimately differentiate the three potential formation mechanisms: hydrodynamic instabilities, shocks, or intermittent ejection.

Recurrent Nova: RS Oph

When RS Ophiuchus was observed at Jodrell Bank on February 13, 1985, it became the first recurrent nova to be observed at radio wavelengths. Since then, the VLA has been used for Target-of-Opportunity observations and has produced a continuing series of observations with unique results.

RS Ophiuichi is a binary star system which underwent a nova event first seen on January 26, 1985. RS Oph has been undergoing a build-up of hydrogen on the surface of its degenerate white dwarf star since its last outburst 18 years ago. When this build-up reaches a critical mass of about 0.0001 solar masses, the surface layer of hydrogen undergoes a thermonuclear flash event which temporarily produces a much brighter star. During this event surface layers are ejected with velocities of the order of a 1000 km/sec.

The VLA observations have shown that RS Oph has an unusual and rapidly evolving radio spectrum, which evolved into a decaying radio source from at least two components in the nova. Strong hydrogen-line absorption in the nova spectrum is probably due to a large amount of intervening gas between us and the nova. The VLA has also afforded the first radio measurements of the expanding angular size of the nova radio source within such a short time of outburst. The interpretation of the larger than expected angular size (0.07 arcseconds a month after outburst) is not yet clear and may await the integration of data from optical, uv, and X-ray wavelength regimes.

G. PUBLICATIONS

Attached as Appendix A is a tabulation of all preprints received in the NRAO Charlottesville library authored by NRAO staff members or based on observations obtained on NRAO telescopes during the reporting period.

H. PUBLIC INFORMATION

During the quarter the NRAO has responded to numerous requests from lecturers, newspapers, magazines, and publishers for visual materials in the form of slides, prints and brochures about the NRAO facilities and scientific results derived therefrom.

The Center for Aerospace Education of Drew University completed the production of a video laser disc which contains many images and descriptive materials provided by the NRAO for use by educators across the country. The

NRAO will help review the content of the disc.

I. GREEN BANK ELECTRONICS

300-ft Spectral Processor

A high-speed spectrometer is being designed and built, and the antique DDP 116 control computer is being replaced with a modern 68000 microprocessor based computer by MASSCOMP. This is a two-in-one project because the DDP 116 hardware and software could not handle the high data rate and complexity put out by the new spectrometer. The spectrometer will provide 2048 total frequency points in up to two independent channels of 40 MHz maximum bandwidth, or up to eight channels of 10 MHz maximum bandwidth for spectral-line observations. Also, it will greatly enhance pulsar searches and measurements of pulse timing, profiles, frequency spectra, and polarization. Timing resolution will be as short as 12 microsec. All frequency spectra can be dedispersed and averaged in time or frequency. Most functions occur in hardware under control of a second MASSCOMP computer. Digital design is at the level of defining word size, addressing schemes and operating speeds. Breadboards of input buffers and switching circuits are being tested. Low power CMOS multipliers for the FFT butterflies are ordered for testing and may replace TTL multipliers tested earlier. Software design for the controller is at the first block diagram and flow chart stage. Design and prototyping of the IF section was temporarily suspended this quarter.

2 to 5 GHz Receiver

A very low-noise system for spectral-line observing on the 300-ft and 140-ft telescopes is being developed. Like the low-noise L-band receiver, the 2-5 GHz receiver uses 2HE mode, high-efficiency, low-spillover feeds having 10% bandwidth, a cooled orthomode transducer and Green Bank designed and built, cooled FET amplifiers. Presently, the Band 1 receiver has two feeds covering 2.90 to 3.15 GHz and 3.15 to 3.40 GHz. Amplifiers cover 2.90 to 3.50 GHz with a system temperature of 25 K measured in the test stand with the feed at the zenith. Tests on the 300-ft telescope during the quarter measured 33 K system temperature. Band 2 amplifiers, under development in Green Bank, will cover 4.60 to 5.10 GHz. Construction continues on the cooled orthomode transducer and feed for the Band 2 receiver.

5 GHz, 7-feed Receiver

A 7-feed receiver will provide significantly improved multibeam continuum mapping capability with the 300-ft telescope at 5 GHz. Northern sky maps down to 10 mJy and analogous to the Palomar Sky Survey (2.7-mm beam circle on the PSS scale with over 300 sources per 6^{o} x 6^{o} "plate") could be produced in 90 days of observing. Also, the galactic plane out to b = $\pm$ 5^{o} could be mapped to 10 mJy rms in only one day. Successive maps would reveal variable sources. Each feed will be dual circularly polarized with cooled orthomode transducers. Each of the 14 receivers consist of a cooled FET

amplifier (4.6 to 5.1 GHz, under development in Green Bank) followed by a bandpass filter, ambient FET amplifiers, and a square-law detector. Fabrication is about two-thirds complete, with internal dewar assembly, feeds, and major receiver components remaining.

Spectral Baseline Improvements

Spectral baseline problems at the 140-ft have limited the sensitivity of spectral-line observations requiring long integration times with wider bandwidths on continuum sources. Persistent efforts over the past two years finally culminated in an improvement of order ten or so this quarter as a result of modifications to the Mark IV autocorrelator IF system and installation of noise adding to the 5-24 GHz Cassegrain receivers.

J. TUCSON ELECTRONICS

70-120 GHz Schottky Mixer Receiver

This new Schottky-mixer receiver covers the 70-120 GHz band with two mixers so as to optimize the performance across the band. The high-frequency half of the receiver, 105-115 GHz, covers the fundamental rotation transitions of the ubiquitous molecular tracer CO and its isotopes. The lower half, 70-90 GHz, includes a wide range of molecular transitions from species such as HCN and HCO+; from these species we may infer the chemistry of molecular clouds as well as the thermodynamical properties of molecular matter. With this receiver on the telescope, we measure a single sideband receiver temperature of 225 K at both 90 and 115 GHz. Telescope tests have revealed some receiver problems which will be rectified before placing the receiver into service in mid-May.

SIS CO (J=1-0) Receiver

In Tucson, we now have a complete working dewar with two SIS junctions installed for the 105-115 GHz band. At CO (J=1-0), this receiver has one-quarter the noise temperature of our present 3-mm receiver. The SIS dewar, in a very preliminary form, will be given its first telescope tests this spring. Since this is the first SIS receiver we have ever tried on the telescope, we expect to gain some considerable insight into the operational problems associated with such receivers.

Bolometer

The 0.8-2.0-mm bolometer was successfully tested on the telescope. Installation of a new bolometer element appears to have eliminated the microphonic problems that plagued this receiver in the past. The beam at 1.4-mm is diffraction limited and the sensitivity in good weather is 2-6 Jy/sec. The optimum sensitivity of the bolometer is likely to be achieved only during times of excellent atmospheric transparency and stability.

The bolometer is scheduled on the telescope for normal operation by visiting astronomers in April.

CO (J = 3-2) Receiver

While observation of any one rotational transition of CO is adequate to tell the astronomer about the presence of molecular gas and the kinematics of that material, it is not adequate to provide information about the amount of gas present or about its temperature and excitation. For the latter purpose it is necessary to observe more than one rotational transition and, if possible, more than one isotopic species. The J = 3-2 rotational transition of CO at 345 GHz is very desirable for such studies of the excitation of molecular clouds. This line, together with the J = 2-1 line at 230 GHz and the J = 1-0 line at 115 GHz, provides a very complete picture of the mass, kinematics, and thermodynamics of molecular clouds.

Work is nearly complete on a simple, single-channel Schottky mixer receiver for the J = 3-2 line of CO and its isotopes. This receiver is meant to allow us to determine the suitability of the telescope and the Kitt Peak site for 345 GHz operation. It is not meant to be our "best effort" 345-GHz receiver.

K. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At lower frequencies the increased strength of the background sources which fill the primary beam more than offset the larger primary beam width and limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beam so the source being imaged is affected directly. For example, at 44 GHz a 20" pointing error causes a 30% change in amplitude.

When the VLA antennas are illuminated by the sun at a low elevation angle, differential temperatures of up to 5 degrees Celsius have been observed across the antenna structure. Under these conditions the pedestal and yoke of the antenna can bend significantly and cause pointing errors of up to one arcminute. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. This process will take until 1986 to complete.

Another, lesser pointing problem which will be addressed in the future is the occurrence of tilts of up to 20 arcseconds in the azimuth axis of a few antennas at certain azimuth angles. This effect is presumably caused by deformations or perturbations in the azimuth bearings. This and other problems, such as an antenna tilt caused by a constant wind force, could be

corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure.

Fifteen antennas now have insulation installed to improve their pointing.

75 MHz Array Development

The proposed array will provide a major new observing capability by giving 20" resolution at a frequency where the current best resolutions are many arcminutes. This capability will enable useful observations of thousands of previously unresolved extragalactic, galactic, and solar system objects. Current capabilities at this frequency enable only total fluxes from the stronger objects, so the proposed array will be truly a ground-breaking instrument. In particular, the array will be especially useful in observing the extended steep-spectrum emission associated with extragalactic radio sources, galactic objects such as supernova remnants, and small-scale, time-variable emission from the Sun, Jupiter, and nearby stars.

The single major obstacle to using such an array lies in the calibration of the data. It is felt that modern computers with self-calibration techniques provide the means to remove the strong phase perturbations introduced by the ionosphere. However, testing of these techniques at these low frequencies is required to better understand the type of algorithm needed. To do this, we wish to equip the current 25-m antennas with simple dipole-type feeds. If modest efficiency results (anything more than 15% will be adequate), we should be able to collect sufficient data from the 25-m antennas at this frequency for testing purposes. Note that if every 25-m antenna had such a feed, the entire 3C and 4C catalogue could be mapped at 75 MHz with the same resolution as the original 1400 MHz aperture synthesis catalogue done at Cambridge. The cost of this outfitting is very modest.

Three antennas now have 75-MHz receivers and a log-periodic antenna outrigged on the side of the 25-m reflectors. Two new dipole feeds have been designed, one a crossed dipole type and the other a quad dipole type. These will be installed on two antennas and testing started during the next quarter.

300-MHz Receiver

Observations of a large number of astronomical objects would benefit from a lower observing frequency than 1.35 GHz, the lowest frequency currently supported on the VLA. Some objects radiate more strongly at lower frequencies while others are so large that a larger field of view than the 30 arcminutes available at 1.35 GHz is needed.

The receiver will be designed so that observations in the range 300-350 MHz can be made with an instantaneous bandwidth of approximately 5 MHz. At this low frequency the VLA 25-m diameter antennas can only be used in prime focus mode. It is known that radio frequency interference, both

locally generated at the VLA and from external sources, will be a significant problem.

Five antennas now have 327-MHz receivers installed, and this system is undergoing test and evaluation. The final feed configuration is expected to be determined next quarter. To reduce local RFI, modifications to some modules have been undertaken (see RFI improvements).

JPL Modules

Feeds and front-ends covering the frequency range 8.0-8.8 GHz will be installed on the VLA primarily to allow reception of the Voyager signal from Neptune at 8415 MHz. Other scientific benefits include the provision of an additional frequency for measurements of continuous spectra and joint observations with the VLB array. There are also some molecular lines of limited interest between 8.8 and 9.2 GHz which may be covered. Finally, the 8.4 GHz front-ends would enable the VLA to be used in planetary radar experiments with the Goldstone transmitter. The NRAO Central Development Laboratory will develop this front-end. The front-end amplifier will probably be a GaAs FET amplifier or an improved HEMT (High Electron Mobility Transistor) amplifier. Cost of this project is to be borne by JPL.

The prototype 8-GHz single-dish system measured transmission from the Voyager Spacecraft with the appropriate signal-to-noise ratio. The second 8.4 GHz front-end has been received from the Central Development Laboratory in Charlottesville and will be installed on Antenna 21.

RFI Improvements

The sensitivity of the 327 MHz and 75 MHz systems will be limited partly by radio frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous usable bandwidth will be investigated.

Three modules appear to be the present major source of RFI. One set of these modules have been modified and preliminary tests indicate good improvement. Another set of these modules will be modified so that a pair of modified antennas may be compared against a pair of unmodified antennas to determine the amount of improvement.

Water Vapor Radiometers

The development of a system to measure the total precipitable water in a path through the atmosphere will serve three purposes. First, the radiometer developed in this project can be used as a prototype of the device which is required at each VLBA station. Second, the radiometer can be used at the VLA to provide estimates of the extinction, giving corrections for observations at 1.3 cm and serving as a historical record of the quality of the VLA site. Finally, if a reliable system can be built at a sufficiently low cost, it would be attractive to add them to the VLA itself.

The device will consist of two radiometers, one operating at about 20.5 GHz the other at about 31 GHz. The radiometer will probably be built around room temperature mixers, with system temperatures of approximately 600 K. The system will be mounted so that it can cover the full range of elevation and probably the full range in azimuth as well. The concept is straightforward. The engineering effort will concentrate on the problem of achieving high gain stability at a reasonable cost.

The RF components for the water-vapor radiometers have been procured and are being assembled for testing. The project is manpower limited.

L. CHARLOTTESVILLE ELECTRONICS

Cryogenic Front-End Development

Microwave front-ends utilizing either field-effect-transistors (FET) or high-electron-mobility-transistors (HEMT) have been under development since early 1984. The same generic design will operate between 2.3 GHz and 23 GHz for use on the VLBA project or specifically at 8.4 GHz for Voyager/Neptune observations with the VLA. The design emphasis is on very low noise, high reliability, and low size and weight for ease of installation and maintenance. A first prototype 8.4 GHz front-end was shipped to the VLA for tests in August 1984 and is performing satisfactorily.

During this quarter a second 8.4 GHz front-end was shipped to the VLA for interferometer tests. The front-end has a noise temperature of approximately 30 K and weighs approximately 50 pounds. A study is being made of the maximum tolerable vacuum leak rate and also of mechanical stresses introduced by mounting of the front-end.

HEMT Device Development

A joint NRAO/JPL, \$150 k/\$200 k support program of Cornell/GE for development of HEMT transistor devices giving as design goals < 10 K noise at 8 GHz and < 30 K at 23 GHz was in effect during CY 84. These noise temperatures would provide approximately a factor of 1.4 system sensitivity improvement compared to FET amplifiers and would allow observations to be performed in one-half of the telescope time. The 8 GHz design goal was met in August 1984 by a GE device which gave 8.5 K at 8.4 GHz and 3.5 K at 3.3 GHz; the 23 GHz goal was not achieved. Cornell is continuing the work with other support, and GE has received a contract extension from JPL to supply 75 HEMT devices for use in the Voyager/Neptune receivers.

During this quarter no additional HEMT's were received from Cornell or GE due to fabrication problems; however, a recent wafer of approximately 300 devices at GE had 70% yield but has not been RF tested.

Schottky-Diode Millimeter-Wave Mixer Development

Cryogenically cooled, Schottky-diode mixers have been in use for almost all millimeter-wave astronomy for the past ten years. NRAO has pioneered the development of the mixers, both in circuit design and, by contract to the University of Virginia, in the development of the diode devices. Mixers covering 90-115 GHz and 200-270 GHz are in heavy use at the NRAO 12-m telescope and work continued in Charlottesville this quarter on the fabrication of units to cover 70-90 GHz and 270-290 GHz.

Superconducting Junction (SIS) Millimeter-Wave Mixer Development

The SIS mixers have theoretical noise temperatures many times lower than diode mixers and experimentally have given a factor of two improvement in sensitivity at 115 GHz. It is believed that most future astronomy between frequencies of 40 and 500 GHz will be performed with SIS mixer receivers. The development involves circuit design and testing at NRAO and SIS device fabrication by contracts with the University of Virginia and the National Bureau of Standards. Recently some all-niobium junctions (which should have higher reliability) have been fabricated by Hypres, Inc. through a Navy contract and have been made available to NRAO for testing.

A 115-GHz SIS receiver was completed this quarter and has been shipped to Tucson for further tests and astronomical use. The design of a 230 GHz SIS receiver is proceeding with impedance measurements of a low-frequency model.

Planar Mixer-Antenna Development

The goal of this research is to provide the millimeter-wave equivalent of the optical photographic plate; i.e., a substrate patterned with antenna-feed elements and either SIS devices or planar Schottky-diodes forming many receivers. This "multi-beaming" would greatly advance the speed or sensitivity of millimeter-wave astronomy. At the present time the system aspects of the problem are being investigated and the radiation patterns of low frequency planar log-periodic antennas are being measured.

Hybrid-Spectrometer

A spectrometer which is a hybrid of analog-filter and digital-correlator techniques is under construction for providing 1536 channels and 2.4 GHz bandwidth on the Tucson 12-meter telescope. It is shown in NRAO Electronic Division Internal Report No. 248 that this hybrid approach gives much lower cost than an all-digital or all-analog system; this is very important for future millimeter-wave astronomy arrays. The present goal is to complete and test one-eighth of the Tucson system by the end of 1985. The first filter module has been completed and all digital boards have been designed.

M. ENGINEERING DIVISION

140-ft Improvements

The 140-ft project consists of the design of a polarization splitter with appropriate radome cover to be used in the new X, K, and KU band feed system. This quarter a basic frame was fabricated except for installation of the wire grid. The design of the radome was started and some material tests made.

300-ft Improvements

The 300-ft focal point structural modifications will provide a limited north south movement of the receiver system to improve the over-all efficiency of the antenna. The design of the moving components was completed this quarter, and design of the modifications to the building was started.

N. VLA COMPUTER DIVISION

New On-Line System

The major upgrade to the on-line system at the VLA is progressing well. The plan encompasses a complete change of the ModComp computers which control and monitor the telescope and acquire the scientific data for later reduction. The upgrade will extend over several years, with final conversion to the new system planned for 1986. The new systems will allow for added capabilities in control of the telescope and additional programs for the initial calibration and editing of telescope data; these additional features are not available now because of the limited speed and memory in the existing systems. In addition, support for the NASA Voyager encounter with Neptune will be provided. The decision was made in 1984 to continue with ModComp as the vendor for the on-line computers, primarily for software compatibility reasons. Two development computers (ModComp Classic II/75's) and some peripherals were purchased in 1984, with the option of supplementing or upgrading them in 1985 when ModComp could provide 32-bit capabilities in a new line of computers. These development systems have been used for work on the software needed for controlling the VLA as is presently done.

During the first quarter of 1985, it was decided to change to the new 32-bit computers (Classic 32/85's) now offered by ModComp. These systems will be bought in mid-1985 and will complete the required hardware purchases for the new on-line system. Full allowance for trade-in of the Classic II/75's bought in 1984 will be applied to the new purchase.

Pipeline System

The Pipeline system of computers at the VLA is a network of several PDP-11 computers, FPS array processors and shared disks which allows high speed mapping of VLA data. It is most useful for large spectral line projects but also provides continuum capability that is not available in other systems. The Pipeline has had a chequered history over the past several years because of problems with hardware and very special-purpose software required for a complex interconnection of many different modules. However, the Pipeline has been in fairly regular use by observers for about a year and has produced many useful results.

Some problems with the hardware still exist; the Pipeline system is fragile and requires continuing effort on the part of hardware and software staff to ensure that it operates properly. Operation of the system is awkward, especially in periods of high demand, and there are still a number of features which have not been implemented. Improvements to the operation and user interface are progressing.

In the first quarter of 1985, additional capabilities for the display of maps and visibility data were added to the DISPLAY PDP-11 on the Pipeline. The user interfaces to this part of the system were much improved. During a visit by W. Brouw (Netherlands Foundation for Radio Astronomy) in February, significant improvements were made to the mapping portion of the Pipeline. The mapping speed was increased by about a factor of two for large maps and for baseline-time displays of visibility data. Various other, more minor, changes were also made.

O. AIPS

To improve the debugging of AIPS, the project is switching to a three-version configuration with all three versions being maintained at both the VLA and Charlottesville. The staff will use the active code-development area (TST), visitors will often use the code-correction version (NEW), and a frozen version (OLD) will be shipped to non-NRAO sites and used by very cautious visitors. A lot of changes anticipating this conversion have been made, but the conversion will not be fully implemented until some time in April. In addition, several fundamental areas have been revised to make the system more reliable. Other notable changes include correction of serious errors in the mathematics and programming of IMFIT--models may now be fit correctly in much less time. The tables package received further development, including a sort task. Work on the calibration (VLBA-driven) package of subroutines has begun.

Some changes have been made in the AIPS management structure. Eric Greisen has been officially designated as AIPS Project Manager, a position he has been filling unofficially for the past two years. Alan Bridle has been asked to serve as Scientific Staff Liaison/Coordinator. He will chair AIPS software priority meetings and help coordinate other AIPS activities. An AIPS Management Advisory Group has been formed for the purpose of

advising the Project Manager on management matters. The group consists of Alan Bridle (Chairman), Ron Ekers, Eric Greisen, Gareth Hunt, and Bob Burns. Bill Cotton, who has chaired the VLBA post-processing group for the past year, will serve as the VLBA Post-Processing Representative, coordinating (with Eric) all AIPS/VLBA activities.

P. SUPERCOMPUTER INITIATIVE

Conceptual Proposal to the NSF for a Supercomputer

Because of increasing use of image enhancement techniques and increases in the hardware of the VLA telescope, available computer resources at the VLA have not kept pace with demand. In formulating a long-term computer plan, the NRAO has investigated the requirements for processing the data output from the VLA and other synthesis arrays. This work has extended over the past three years and has involved the analysis of the projected observing programs, the translation of the expected data into computer requirements and the determination of the technical solutions available to handle the problem. Assistance has been provided by the NRAO Computer Advisory Group (consisting of prominent professionals in the computer field) and a Scientific Review Panel (consisting of radio astronomers).

The conclusions reached imply the need for a supercomputer dedicated to the processing of synthesis array data. Such a facility requires, in addition to the raw computational power, highly interactive digital image displays and very high-speed input/output to the computer in order to make the processing of digital images as scientifically productive as possible. The future demand for computer resources will exceed NRAO's total capacity by more than a factor of twenty-five.

NRAO has prepared a Conceptual Proposal for the acquisition of a supercomputer. Entitled "A Supercomputer for Radio Astronomical Imaging," the document was submitted to the National Science Foundation in March 1985. The proposed supercomputer facility is estimated to cost $18.8 million with and estimated annual operating cost of $5.6 million.

CRAY Project

NRAO personnel have been making use of the Cray X/MP computer located at Vector Production in Los Angeles. The NRAO currently has access to 40 service units (several hours worth) on this machine, contracted by the National Science Foundation through their supercomputer access program. The purpose of this work is to gain experience in the use of supercomputers and to develop existing software for use in this environment. Current work is concentrating on two areas: the development of the AIPS software package on the machine and the test and development of algorithms such as VM. About 80% of the allotted time has been used. A proposal for additional time is currently being prepared.

Q. VERY LONG BASELINE ARRAY

The VLBA project groups report progress on the project for the first quarter of CY 85 as follows:

Sites

A design contract was signed with the A/E firm of Stevens, Mallory, Pearl and Campbell, and they were authorized to proceed with the design of the Pie Town site. The first conference was held in their office in Albuquerque in January.

Atmospheric water vapor measurements were completed in Hawaii and reports are being prepared. RFI tests were completed at Kitt Peak and the reports were issued for review. RFI tests were started at Fort Davis. Discussions with the Los Alamos National Laboratory for the location of an antenna there continued. The Voice of America personnel were consulted relative to the compatibility of our proposed site and their proposed site in Puerto Rico.

Antennas

During this quarter the antenna subcontractor, Universal Antennas, Inc., (UAI) completed the computer model of the antenna and performed the gravity analysis of the structure. After several iterations with NRAO, they confirmed the NRAO results. UAI prepared configuration layouts and initial design drawings and completed initial configuration drawings. Wind and thermal analyses were also completed this quarter.

Radiation Systems, Inc., performed the panel design and analysis; the first results of this effort are available.

Near the end of the quarter, dynamic analysis of the structure, drive and control design, and servo design began.

NRAO engineering continued to review and monitor the efforts of the antenna subcontractor.

Electronics

Progress in the electronics area over the past year was reviewed at the design workshop held in Socorro January 22-24, and generally approved. It was concluded that the higher-accuracy specification for the subreflectors should be included in the procurement planning.

On January 28 a meeting was held at Green Bank between NRAO electronics and cryogenics personnel and two representatives of Cryogenics Technology Inc. (CTI). Four model 22 refrigerators that had been returned by NRAO to CTI, and overhauled by them, were inspected. Another unit which had been removed after 3000 hours on the NRAO test setup was also inspected. It was concluded that the mechanical tolerances on units being supplied or

overhauled by CTI has improved, and the heavy wear on the bushings found in earlier units appears to have been overcome. Arrangements were made for a continuing dialogue with CTI on the performance of units under test or in operation at NRAO.

A second front end for the 8.4 GHz band was completed and tested in the Charlottesville laboratory. This unit showed faster cool-down than the first unit, 7 hours compared with 11 hours, largely due to use of a lighter polarizer. The frequency bandwidth was also improved as a result of further optimization of the amplifier design. This unit is being installed on the VLA as a prototype for the Voyager project and will provide valuable experience on reliability and maintenance for the VLBA. Construction of the modified 1.5 GHz front end using a CTI model 350 refrigerator progressed on schedule at Green Bank, and tests will be made during the next quarter. A prototype of the 2-16 GHz synthesizer units for the local oscillator system was tested at Green Bank in January, and further development is continuing.

Technical studies in progress include the design of the round-trip phase measurement system for the local oscillator, and the distribution of gain within the front-end and IF units of the receiving system. The latter determines the dynamic range of signal channels and thus the threshold flux density levels for certain types of interference.

Data Recording

During this quarter the block diagram of the VLBA data acquisition system (DAS) was finalized and agreed on at the Socorro Design Review. The DAS includes a very flexible formatter which allows the VLBA format to be under software control. Both the MKIII and the new VLBA format can be generated. The details of a VLBA format are being designed to optimize performance with future improvements in magnetic tape and head technology.

VLBA recorder development work continued with the fabrication of additional prototype head stacks. Three new head stacks with heads 20 microns wide were successfully fabricated. Tests of the performance using thin (0.8 and 0.6 micron) tape showed that this tape should be acceptable for VLBA use. The thinner tape will allow the use of smaller reels and will reduce shipping costs. The data playback system (DPS) design progressed and more details of the DPS/Processor interface were worked out. A complete specification of the interface should be complete by 1 July 1985.

Other accomplishments of this quarter include the design of custom wirewrap panels which interface with the standard VME bus and the selection of a microprocessor development system with emulator for the 68000 series microprocessors. (VME bus and 68000 series microprocessor are both standards selected for the VLBA.)

Correlator

A number of important decisions affecting the correlator were made at the design workshop in Socorro in January. The decision to support 2 and 4-level quantization impacts the design of the VLSI correlator chip, while

the setting of the maximum dump rate at 0.5 Hz determines the output data rate of the correlator.

Correlator Architecture. A number of different architectures have been considered for the correlator. Among these was the GLOBAL BUS which would provide extreme flexibility in the interconnection of the correlator array and the data playback system. This system, however, is quite expensive to design and build and a simpler, less expensive architecture is being considered. This is a Channel-by-Channel system where the inputs to the correlator arrays from the Data Playback Systems are grouped by channels rather than stations. This system lends itself most easily to the expansion of the number of channels rather than the number of stations. The architectural design report was completed during this quarter. This report details the architecture of a Channel-by-Channel system that will support 10/14/20 stations in the full/half/quarter modes. Plans for the input crossbar system are to support up to a maximum of 24 Data Playback systems with 16 channels each with an 8 MHz bandwidth.

Output Data Flow. Several alternative schemes were examined for handling the data after readout from the correlator VLSI chips. A mixture of Data Signal Processor chips and 68000 series microcomputers will take care of the accumulation and digital filtering of the outputs as well as computation of the geometric models. FFT and magnetic tape output may be handled in a number of ways. A distributed system of 68000 microcomputers and a small array processor would be one solution, or a larger array processor driven by an Aptec interface device and a small VAX. In either case, the bulk of the data would not need to pass through the expensive VAX environment, permitting a rather small VAX to serve as the control computer.

VLSI. Work on the VLSI correlator chip continued, including the design of the gate array. The choice of 2/4 level quantization made the design more difficult because of the need for a 4-level multiplier. This increases the number of gates needed for the multipliers and increases the difficulty of doing the design in 6,000 gate, 3 micron technology. Two micron technology that has faster speed and in turn requires less pipelining and fewer gates was considered. Although the development of 2-micron technology is somewhat more costly, it has the promise of requiring fewer gates for the same or better performance. By the time production quantities are needed, the cost of 2 micron chips are forecasted to be the same or lower than 3-micron chips.

The VLSI chip being developed for the Australian Telescope Array has also been considered for the correlator. Sample quantities have been tested by the AT correlator group, and it appears that the performance is approaching that required of the VLBA correlator. However, the chip is only specified to run at a 12 MHz clock rate and is not guaranteed beyond that. VLBA requirements are for a chip that will operate in excess of 16 MHz clock rate--on the order of 20 MHz. Based on present information, it does not appear that the AT chip will be used.

The preliminary design on the MENTOR work station was completed this quarter. Simulation of the design for an initial evaluation of the performance is now ready to begin.

Systems Engineering

During this quarter, Systems Engineering concentrated on establishing specifications for the major subsystems of the VLBA. The design workshops held at the end of January in Socorro resulted in several important decisions. The quantization schemes to be supported were established, as well as some details of the recording format. Many specifications of the correlator are now final, including the maximum dump rate and most details of the fringe processing. There was some progress in defining the playback to correlator interface; it has been established in outline form, and should be specified in detail during the next quarter. In the Monitor and Control system, the specifications of the serial bus for communication within a station were finalized. A plan is being developed for the testing and installation of the first set of receiving, signal processing, recording, and monitor/control equipment so that an integrated system test can be accomplished, either at Green Bank or the VLA, before the equipment is sent to the first antenna station (Pie Town).

R. PERSONNEL CHANGES

The following new appointments, promotions, and departures occurred during the reporting period:

Appointments

Name	Title	Location
P. A. Vanden Bout	Director	Directors Office - CV
T. M. Bania	Visiting Assoc. Scientist	Basic Research - CV
Shing-Kuo Pan	Electronics Engineer I	Electronics - CV
J. L. Lamb	Electronics Engineer I	Electronics - CV
S. A. Baum	Jr. Research Associate	Basic Research - CV

Promotions

R. L. Brown	Associate Director, Operations	Directors Office - CV

Departures

J. W. Findlay (retirement)	Senior Scientist	Basic Research - CV
L. M. Temple (death)	Head/Antenna Division	Engr. Services - SO
C. G. Kotanyi (end contract)	Research Associate	Basic Research - SO

The duties of the Associate Director for Operations include: serving as Acting Director in the Director's absence, serving as the Charlottesville "site director" and as a focus for the Observatory-wide scientific staff and assisting the Director in the development of long-range plans and in AUI Board and NSF related activities. The chief benefit of this reorganization is to provide the Director's office with a scientific perspective complimentary to the fiscal and technical perspectives of the other Associate Directors. R. L. Brown continued to serve as site director for Tucson following this promotion.

APPENDIX A

PUBLICATIONS

ALL PREPRINTS

AUTHOR(S)	TITLE
ALLER, H.D.; REYNOLDS, S.P.	The Decrease with Time of the Radio Flux of the Crab Nebula
ANANTHARAMAIAH, K.R.; ERICKSON, W.C. RADHAKRISHNAN, V.	Observations of Radio Recombination Lines with Principal Quantum Number 456<n<634 Towards Cassiopiea A
ANTONUCCI, R.R.J.; MILLER, J.S.	Spectropolarimetry and the Nature of NGC 1068
BAAN, W.A.	Powerful Extragalactic Masers
BARCIA, A.; GOMEZ-GONZALEZ, J. LOCKAMN, F.J.; PLANESAS, P	Radio Recombination Lines from the Galactic Plane in Cygnus
BARTEL, N.; RATNER, M.I. SHAPIRO, I.I.; CAPPALO, R.J. ET AL	Pulsar Astrometry via VLBI
BECKER, R.H.; HELFAND, D.J.	A New Class of Nonthermal Radio Sources
BECKER, R.H.; MARKERT, T. DONAHUE, M.	Radio and X-ray Observations of G11.2-0.3 and G41.1-0.3
BECKER, R.H.; WHITE, R.L.	Nonthermal Radio Emission from HD193793 amd V410 Tau
BENNETT, C.L.; LAWRENCE, C.R. BURKE, B.F.	5 GHz Counts from the MG Survey
BROWNE, I.W.A.; MANTOVANI, F. MUXLOW, T.W.B.; PADRIELLI, L. ROMNEY, J.D.	The Variability and Radio Structure of 3C159
CAILLAULT, J.-P.; CHANAN, G.A. HELFAND, D.J.; PATTERSON, J. ET AL	The Peculiar X-ray and Radio Star AS431
COLEMAN, P.H.; CONDON, J.J.	A High-Resolution VLA Survey of the alpha = 08h52m15s, delta = +17 deg 16' Field
COLEMAN, P.H.; CONDON, J.J. HAZARD, C.	Complete Samples of Active Extragalactic Objects. III. A 1411-Mhz VLA Survey Centered on alpha = 08h54m, delta = +17 deg 30'
COWAN, J.J.; BRANCH, D.	Radio Detection of Historical Supernovae and H II Regions in M83
CROVISIER, J.; DICKEY, J.M. KAZES, I.	21-cm Absorption Observations Towards a Cold Diffuse Cloud

ALL PREPRINTS

AUTHOR(S)	TITLE
ECKART, A.; WITZEL, A. BIERMANN, P.; PEARSON, T.J. ET AL	Milliarcsecond Structure of 1928+738: Apparent Superluminal Motion Along an Extended Jet?
FABER, M.T.; ARCHER, J.W.	Computer-Aided Testing of Mixers Between 90 GHz and 350 GHz
FABER, M.T.; ARCHER, J.W.	W-band Ultra Low-Noise, Fixed-Tuned, Broadband Mixer
FISCHER, J.; SANDERS, D.B. SIMON, M.; SOLOMON, P.M.	High Velocity Gas Flows Associated with H2 Emission Regions: How Are They Related and What Powers Them?
FIX, J.D.; MUTEL, R.L.	A Search for Hydroxyl Masers in M33
FORD, H.C.; CRANE, P.C. JACOBY, G.H.; LAWRIE, D.G. VAN DER HULST, J.M.	Bubbles and Jets in the Center of M51
GIL, J.	Interpulse Beams and Profile Components
GIL, J.	On the Frequency Independence of Pulsar Microstructure Phase
GIOVANNINI, G.; FERETTI, L. ANDERNACH, H.	VLA Observations of the Extended Radio Source Near Coma A
GREEN, D.A.; GULL, S.F.	A Successful Search for New Young Galactic Supernova Remnants
HAMILTON, T.T.; HELFAND, D.J. BECKER, R.H.	A Search for Millisecond Pulsars in Globular Clusters
HELFAND, D.J.; BECKER, R.H.	Origin of the New Axisymmetric Radio Sources
HENKEL, C.; MATTHEWS, H.E. MORRIS, M.; TEREBEY, S. FICH, M.	Molecular Lines in IRC+10 deg 216 and CIT6
HERMSEN, W.; WILSON, T.L. WALMSLEY, C.M.; BATRLA, W.	15NH3 in Orion-KL: The Hot Core Isn't so Hot
HOLLIS, J.M.; CHIN, G. BROWN, R.L.	An Attempt to Detect Mass Loss from alpha Lyrae with the VLA
HUNTER, D.A.; GALLAGHER, J.S. III	HI Photometry of Irregular Galaxies
INAGAKI, S.; SASLAW, W.C.	Equipartition in Multi-component Gravitational Systems

ALL PREPRINTS

AUTHOR(S)	TITLE
JEWELL, P.R.; SCHENEWERK, M.S. SNYDER, L.E.	The Detection of Rotationally Excited OH Emission Toward the Probable Young Planetary Nebula Vy 2-2
JOHNSTON, K.J.; WADE, C.M. FLORKOWSKI, D.R.; DE VEGT, C.	The Position of the Radio/Optical Emission from the Stars HR1099 and UX Ari
KELLERMANN, K.I.	Report of Commission 40, International Astronomical Union
KELLERMANN, K.I.; THOMPSON, A.R.	The Very Long Baseline Array
KRONBERG, P.P.; SRAMEK, R.A.	Discovery of New Variable Radio Sources in the Nucleus of the Nearby Galaxy, Messier 82
LESTER, D.F.; DINERSTEIN, H.L. WERNER, M.W.; HARVEY, P.M. ET AL	Star Formation in the Inner Galaxy: A Far-Infrared and Radio Study of Two HII Regions
LESTRADE, J.; MUTEL, R.L. PRESTON, R.A.; PHILLIPS, R.B.	High Angular Resolution Observations of Stellar Binary Systems
LISZT, H.S.	A Search for O2 Toward NGC 7674
LISZT, H.S.	Structure of Sgr C Observed at Radiofrequencies
LO, K.Y.; BACKER, D.C. EKERS, R.D.; KELLERMANN, K.I. ET AL	On the Size of the Galactic Center Compact Radio Source: Diameter < 20 AU
MARCAIDE, J.M.; BARTEL, N. COHEN, N.L.; GORENSTEIN, M.V. ET AL	Simultaneous Dual-Wavelength VLBI Observations of the Compact Radio Source Near the Galactic Center
MARTIN-PINTADO, J.; WILSON, T.L. JOHNSTON, K.J.; HENKEL, C.	High Resolution Maps of 6 cm Formaldehyde: Clumping in Molecular Clouds
MATTHEWS, H.E.; FRIBERG, P. IRVINE, W.M.	The Detection of Acetaldehyde in Cold Dust Clouds
MAUERSBERGER, R.; WILSON, T.L. BATRLA, W.; WALMSLEY, C.M. HENKEL, C.	Newly Discovered Sources of Non-metastable Ammonia
MENTON, K.M.; JOHNSTON, K.J. WILSON, T.L.; WALMSLEY, C.M. ET AL	VLA Observations of the 9 sub 2 - 10 sub 1 A+ Methanol Masers Toward W3(OH)
MOLNAR, L.A.; REID, M.J. GRINDLAY, J.E.	Confirmation of Radio Periodicity in Cygnus X-3

ALL PREPRINTS

AUTHOR (S)	TITLE
O'DEA, C.P.	Constraints on Bent Beams in Narrow Angle Tail Radio Sources
O'DEA, C.P.; OWEN, F.N.	The Global Properties of a Representative Sample of 51 Narrow Angle Tail Radio Sources in the Directions of Abell Clusters
O'DEA, C.P.; OWEN, F.N.	VLA Observations of 57 Sources in Clusters of Galaxies
ODENWALD, S.F.; SHIVANANDAN, K.	Star Forming Regions near the Supernova Remnant IC-443
PEARSON, T.J.; PERLEY, R.A. READHEAD, A.C.S.	Compact Radio Sources in the 3C Catalog
RADFORD, S.J.E.; BOYNTON, P.E. ULICH, B.L.; PARTRIDGE, R.B. ET AL	A Search for the Sunyaev-Zel'dovich Effect at lambda = 3mm
RICKARD, L.J; BLITZ, L.	Carbon Monoxide Isotope Ratios in Galactic Centers and Disks
RICKARD, L.J; TURNER, B.E. PALMER, P.	More Extragalaxtic Carbon Monoxide
SALPETER, E.E.; DICKEY, J.M.	HI Mapping of Galaxies in the Hercules Cluster
SASLAW, W.C.; NARASIMHA, D. CHITRE, S.M.	The Gravitational Lens as an Astronomical Diagnostic
SEAQUIST, E.R.; BELL, M.B. BIGNELL, R.C.	Radio Studies of the Ionized Gas in the Nucleus of M82
SHEVGAONKAR, R.K.; KUNDU, M.R.	Dual Frequency Observations of Solar Microwave Bursts Using the VLA
SHONE, D.L.; PORCAS, R.W. ZENSUS, J.A.	Combined MERLIN/VLA Observations of 3C179
SIMONETTI, J.H.; CORDES, J.M. HEESCHEN, D.S.	Flicker of Extragalactic Radio Sources at Two Frequencies
SPANGLER, S.R.; SAKURAI, T.	Limits on Thermal Plasma in the Lobes of the Radio Galaxies 3C 79 and 3C 379.1
THRONSON, H.A. JR; LADA, C.J. HEWAGAMA, T.	The W3 Molecular Cloud
TURNER, B.E.; STEIMLE, T.C.	Interstellar MgO

ALL PREPRINTS

AUTHOR(S)	TITLE
VANDEN BOUT, P.A.; MUNDY, L.G. DAVIS, J.H.; LOREN, R.B. BUTNER, H.	Calibration of Millimeter-Wavelength Spectral Lines - Effect of Harmonic Mixer Response
WILSON, A.S.; SAMARASINHA, N.H. HOGG, D.E.	High Resolution Radio Studies of the Crab Nebula
ZHENG, X.W.; HO, P.T.P. REID, M.J.; SCHNEPS, M.H.	Molecular Clouds Associated with the Compact H II Regions. II. The Rapidly Rotating Condensation Associated with ON1