NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

October 1, 1988 - December 31, 1988

TABLE OF CONTENTS

A. TELESCOPE USAGE 1

B. 140-FT OBSERVING PROGRAMS 1

C. 300-FT OBSERVING PROGRAMS 6

D. 12-M TELESCOPE 6

E. VLA OBSERVING PROGRAMS 8

F. SCIENTIFIC HIGHLIGHTS 20

G. PUBLICATIONS 22

H. CHARLOTTESVILLE ELECTRONICS 22

I. GREEN BANK ELECTRONICS 24

J. 12-M ELECTRONICS 25

K. VLA ELECTRONICS 26

L. AIPS 30

M. VLA COMPUTER 31

N. VERY LONG BASELINE ARRAY 31

O. PERSONNEL 35

APPENDIX A. PREPRINTS

A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the last quarter of 1988.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1845.25	1056.50	1901.50	1506.0
Scheduled maintenance and equipment changes	181.75	45.25	100.00	266.4
Scheduled tests and calibrations	100.50	0.00	139.75	379.7
Time lost	87.50	12.25	176.75	111.4
Actual observing	1757.75	1044.25	1724.75	1394.6

The hours for the 300-ft telescope reflect its usage prior to its collapse on November 15, 1988.

B. 140-FT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-86	Albert, C. (USNA) Blades, J. (STScI) Morton, D. (Herzberg) Lockman, F. J.	Observations of HI combined with an optical study of the galactic halo.
A-90	Avery, L. (Herzberg) MacLeod, J. (Herzberg)	Study at discrete frequencies between 8.125 and 23.939 GHz of the excitation and abundance of carbon chain molecules in TMC-1.
B-488	Snyder, L. (Illinois) Jewell, P. Batrla, W.	Search at 8.7 GHz for the 2(0,2)-(1,0) line of methylamine (CH_2NH_2).
B-493	Bania, T. (Boston) Rood, R. (Virginia) Wilson, T. (MPIR, Bonn)	Measurements at 8.666 GHz of $^3He+$ emission in HII regions and planetary nebulae.
B-512	Bell, M. (Herzberg) Broten, N. (Herzberg) Seaquist, E. (Toronto)	Search for high velocity infalling HI in active galaxies.
C-252	Claussen, M. (NRL) Kleinmann, S. (Massachussets)	Observations at 18 cm of OH masers from an infrared flux-limited sample of oxygen rich stars.

No.	Observer(s)	Program
C-254	Crane, P. (ESO)	Observations at 3.333 GHz of CH lines toward ζOph.
D-157	Danly, L. (Wisconsin) Savage, B. (Wisconsin) Lockman, F. J.	Observations of HI toward galactic halo stars.
E-54	Elvis, M. (CFA) Wilkes, B. (CFA) Lockman, F. J.	Observations at 21 cm of the X-ray spectra of QSOs.
L-218	Lockman, F. J.	Observations of peculiar HI lines.
M-227	Batrla, W. Caswell, J. (CSIRO) Haynes, R. (CSIRO) Olnon, F. (Leiden) Winnberg, A. (Chalmers) Maddalena, R.	Observations at 1.3 cm for H_2O maser sources in the galactic plane.
M-283	Likkel, L. (UCLA)	Monitor at 1.3 cm unusual H_2O emission from two IRAS sources.
M-284	Brown, R. (Monash) Godfrey, P. (Monash) Henkel, C. (MPIR) Irvine, W. (Massachusetts) Madden, S. (Massachusetts) Wilson, T. (MPIR) Maddalena, R.	Time variability study at 1.5 cm of ammonia masers.
M-288	Bally, J. (Bell Labs) Maddalena, R.	Observations of neutral HI toward selected areas of Orion and Monoceros.
O-37	Odenwald, S. (NRL) Lockman, F. J.	Observations of HI in cometary infrared clouds.
P-143	Petuchowski, S. (NASA) Bennett, C. (NASA) Powers, T. (NASA)	Search for highly redshifted OH at discrete frequencies between 750 and 1000 MHz.
T-243	Thuan, T. (Virginia) Fouque, P. (Meudon) Schneider, S. (Massachusetts)	Hydrogen survey of southern dwarf galaxies.
T-246	Turner, B. Lanping, X. (Beijing) Rickard, L. J (NRL)	Observations at 23.7 GHz of IRAS/cirrus cores to obtain temperatures.

No.	Observer(s)	Program
T-247	Turner, B. Lanping, X. (Beijing) Rickard, L. J (NRL)	Search at 1.4 cm for C_2S, C_3S, C_2O, and C_3O in IRAS/cirrus clouds.
T-253	Turner, B.	Search at 11.13 and 14.84 GHz for acetylene dimer $(C_2H_2)_2$.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
D-484	Backer, D. (Berkeley) Foster, R. (Berkeley) Kulkarni, S. (Caltech) Taylor, J. (Princeton)	Timing observations at 1355 MHz of PSR 1821-24 and other millisecond pulsars.
D-513	Backer, D. (Berkeley) Wolszczan, A. (NAIC)	Timing observations at 1667 MHz of PSR 1849+00.

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

A - Arecibo 1000 ft
B - Effelsberg, MPIR 100 m
Dm - Goldstone 64 m
F - Fort Davis 85 ft
G - Green Bank 140 ft
H - Hat Creek 85 ft
I - Iowa 60 ft
Jb - Jodrell Bank Mk II 25 m
Km - Haystack 120 ft
Kw - Westford 18 m
Lb - Bologna 25 m
Lm - Medicina 32 m
N - NRL Maryland Point 85 ft
O - Owens Valley 130 ft
Pt - Pietown 25 m
Sn - Onsala 20 m
S - Onsala 25 m
Wn - Westerbork n=1-14x26 m
Yn - Socorro n=1-27x25m
Z - Torun 15 m

No.	Observer(s)	Program
A-19V	Andre, P. (IRAM) Lestrade, J-F. (JPL) Montmerle, T. (IRAM) Phillips, R. (Haystack) Mutel, R. (Iowa)	Investigation at 6 cm of a young radio emitting magnetic B star in the ρOphiuchi cloud, with telescopes G, O, and Y27.
AH-42V	Neff, S. (NASA)	Observations at 18 cm of NGC 1068, with telescopes B and G.
B-81V	Bartel, N. (CFA) Rogers, A. (MIT) Shapiro, I. (MIT)	Observations at 6 cm of SN1979c to monitor expansion and morphology, with telescopes G, O, and Y27.

No.	Observer(s)	Program
C-51V	Clegg, A. (Cornell) Cordes, J. (Cornell) Spangler, S. (Iowa)	Measurements at 6 and 18 cm of the angular broadening of the extragalactic sources behind the supernova remnant CTA 1, with telescopes B, Km, G, O, and Y27.
C-253V	Clark, T. (NASA) Vandenberg, N. (Interferometrics) Shaffer,D. (Interferometrics) Lundqvist, G. (Interferometrics) Gregovich, G. (Interferometrics) Baver, K. (ST Systems) Ryan, J. (NASA) Wu, A. (Bendix) Allshouse, R. (Bendix) Allen, H. (Bendix)	Observations at S and X bands to monitor baseline stability and motion of the North American plate, with telescopes Dm, F, G, Kw, and O.
F-18V	Fanti, C. (Bologna) Fanti, R. (Bologna) Spencer, R. (Manchester) Venturi, T. (Bologna) Schilizzi, R. (NFRA) Rendong, N. (Beijing) van Breugel, W. (Berkeley) Muxlow, T. (Manchester)	Studies at 18 cm of the structure of 3C 243, with telescopes B, So, Wn, Jb, Lm, Z, Km, G, I, O, Y27, and telescopes of the Merlin Network.
H-46V	Hummel, C. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Quirrenbach,A. (MPIR, Bonn) Schalinski, C. (MPIR, Bonn) Witzel, A. (MPIR, Bonn)	Observations at 18 cm of the S5 quasar 0836+71, with telescopes B, Lm, Jb, So, Wn, Z, Km, G, N, F, O, H, Y1, Pt, and telescopes of the Merlin Network.
H-260V	Hough, D. (JPL) Porcas, R. (MPIR, Bonn) Readhead, A. (Caltech) Zensus, A. (Caltech)	Pilot survey at 8.4 GHz of very weak nuclei in double-lobed quasars, with telescopes B, Dm, Ds, G, and Y27.
J-49V	Jones, D. (JPL) Preston, R. (JPL) Wehrle, A. (Caltech)	Studies at 18 cm of the long term evolution of NGC 6251, with telescopes B, So, Lm, Wn, Jb, Km, G, F, O, Y27, and Pt, and telescopes of the Deep Space Network.
L-49V	Lestrade, J-F. (JPL) Boloh, R. (JPL) Mutel, R. (Iowa) Niell, A. (Haystack) Preston, R. (JPL)	Observations at 18 cm of 15 RSCVn binaries for mapping and astrometry, with telescopes B, O, G, and Y27.

No.	Observer(s)	Program
L54V	Langston, G. (NRL) Porcas, R. (MPIR, Bonn) Simon, R. (NRL) Johnston, K. (NRL) Browne, I. (Manchester)	Studies at 18 cm of the curved luminous jet of blazar 3C 446, with telescopes B, So, Lm, Wn, Jb, Km, G, I, F, O, N, Y1, Pt, and telescopes of the Merlin Network.
M-93V	Marr, J. (Berkeley) Backer, D. (Berkeley)	Study at 6 cm the compact structure in NGC 1275, with telescopes B, So, Lm, Wn, Jb, Km, N, G, I, F, O, H, and Pt.
M-100V	Marscher, A. (Boston) Rickett, B. (San Diego) Padriella, L. (Bologna) Romney, J. Bartel, N. (CFA)	Monitoring at 6 cm and 18 cm of NRAO 140, with telescopes B, Lm, So, Wn, Jb, Km, G, I, F, O, N, Y1, and Pt.
M-101V	McHardy, I. (Oxford) Marscher, A. (Boston) Gear, W. (Royal Observatory)	Observations at 6 and 18 cm of the extremely variable quasar, with telescopes B, Lm, So, Wn, Jb, Km, G, F, I, O, N, Y1, and Pt.
P-85V	Pearson, T. (Caltech) Riley, J. (Cambridge)	Studies at 6 cm of 4C 74.26, with telescopes B, So, Lm, Wn, Jb, Km, G, O, and Y27.
P-86V	Porcas, R. (MPIR, Bonn)	Monitor of 3C 179 at 3.6 cm, with telescopes B, F, G, Km, Lb, O, Sn, and Yn.
R-46V	Roberts, D. (Brandeis) Wardle, J. (Brandeis) Cawthorne, T. (Brandeis) Brown, L. (Brandeis) Gabuzda, D. (Brandeis) Holdaway, M. (Brandeis) Kollgard, R. (Brandeis)	Survey at 6 cm of the linear polarization structures of selected sources, with telescopes B, Lm, Wn, Km, G, F, O, and Y27.
S-79V	Spangler, S. (Iowa) Mutel, R. (Iowa) Fey, A. (Iowa) Cordes, J. (Cornell)	Measurements at 6 and 18 cm of interstellar scattering in a region in Cygnus, with telescopes B, Lm, Km, G, O, and Y27.
U-18V	Unwin, S. (Caltech) Davis, R. (Manchester)	Studies at 18 cm of the 3C 273 jet to a radius of 120 pc, with telescopes A, B, Jb, Wn, So, Lm, Z, Km, G, N, I, F, O, H, Y1, and Pt.
W-42V	Walker, R. C. Benson, J. Unwin, S. (Caltech)	Monitor at 6 cm of superluminal motions in 3C 120, with telescopes A, B, Wn, Jb, So, Km, N, G, I, F, O, H, and Pt.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-082	Aller, H. (Michigan) Aller, M. (Michigan) Payne, H. (STScI)	Observations at 880, 1400, and 2700 MHz of low frequency variable sources.
C-238	Broderick, J. (VPI&SU) Condon, J. Seielstad, G.	Sky survey at 4.8 GHz covering $-2 < \delta < +77$.
G-304	Gregory, P. (British Columbia)	Radio patrol variable source study at 4.8 GHz covering $0 < \delta < +73$.

The following line program was conducted during this quarter.

No.	Observer(s)	Program
K-313	Kerr, F. (Maryland) Henning, P. (Maryland)	Further search for galaxies in the Zone of Avoidance by the study of HI.

The following SETI search, commensurate with other programs, was conducted during this quarter.

No.	Observer(s)	Program
B-454	Bowyer, S. (Berkeley) Werthimer, D. (Berkeley)	Commensal SETI at any available frequency.

D. 12-M TELESCOPE

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-503	Butner, H. (Texas) Loren, R. (Texas)	Study of temperature gradients in low-mass cores.
B-508	Baudry, A. (Bordeaux) Brouillet, N. (Bordeaux) Combes, F. (Meudon)	Study of CO spatial distribution in M81.
B-509	Black, J. (Arizona) van Dishoeck, E. (Caltech) Gredel, R. (ESO)	Study of structure and chemistry of translucent molecular clouds.

No.	Observer(s)	Program
B-510	Bushouse, H. (NASA) Lamb, S. (NASA) Lord, S. (NASA) Lo, K. (Illinois) Werner, M. (NASA)	Study of molecular gas content of strongly interacting galaxies.
C-251	Clancy, R. (Colorado) Muhleman, D. (Caltech)	Study of Venus and Mars CO.
D-162	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of evolution of extragalactic radio sources at mm wavelengths.
F-103	Fabian, A. (Cambridge) Lasenby, A. (Cambridge) Lasenby, J. (Cambridge)	Observations to confirm detection of 3.06 mm Fe XXIV line in Cas A.
H-253	Hollis, J. M. (NASA) Lovas, F. (NBS) Jewell, P.	The search for CH_2 (methylene) in Orion's hot core.
H-254	Hogg, D.	Study of the CO content of two starburst galaxies.
H-261	Hogg, D. Roberts, M.	Search for CO in SO galaxies.
L-223	Lewis, B. M. (NAIC)	Study to explore, at 115 GHz, the similarities of DGE stars with/out 1612 MHz masers.
L-230	Latter, W. (Arizona) Maloney, P. (Leiden) te Lintel, P. (Leiden)	CO observations of evolved mass-losing AGB stars.
M-286	Mangum, J. (Virginia) Wootten, H. A. Mundy, L. (Caltech)	A molecular line study of the pre-stellar condensations in DR21(OH).
M-287	Mirabel, F. (Caltech) Sanders, D. (Caltech) Kazes, I. (Paris)	CO observations of radio galaxies.
M-291	Meyers-Rice, B. (Arizona) Lada, C. (Arizona)	^{13}CO mass estimates of a spectacular outflow source.
O-39	Odenwald, S. (NRL) Schwartz, P. (NRL)	CO study of YSO candidates in the Cygnus-X region.
P-144	Partridge, R. B. (Haverford) Sheth, R. (Haverford)	Microwave spectral indices of star-forming galaxies.

No.	Observer(s)	Program
P-145	Petuchowski, S. (NASA) Bennett, C. (NASA)	Follow-up observations of vibrationally-excited H_2O.
S-321	Sage, L. (NMIMT)	^{12}CO J=1-0 observations of a distance-limited sample of nearby galaxies.
S-322	Sage, L. (NMIMT) Shore, S. (NMIMT)	CS J=2-1 emission from a distance-limited sample of nearby galaxies.
S-325	Sage, L. (NMIMT) Wrobel, J. (NMIMT)	^{13}CO J=1-0 and ^{12}CO J=2-1 observations of SO galaxies.
T-249	Turner, B. Amano, T. (NRC, Canada) Feldman, P. (NRC, Canada)	A search for protonated methyl cyanide (CH_3CNH^+).
T-250	Terebey, S. (Caltech) Van Buren, D. (Johns Hopkins) Ziskin, D. (Johns Hopkins)	Study of CO outflows as tracers of propagating star formation in the λ Orionis shell.
T-263	Terebey, S. (Caltech) Ziskin, D. (Johns Hopkins) Fich, M. (Waterloo) Myers, P. (CFA)	CO observations of IRAS sources.
W-255	Walker, C. (Arizona) Carlstrom, J. (Berkeley) Martin, R. (Arizona) Jackson, J. (MPIfEP)	A CS (J=2-1) study of infrared bright galaxies.
Y-6	Yun, M. (CFA) Ho, P. (CFA)	Study of molecular gas associated with neutral streamers around M82.
Z-71	Ziurys, L. (Massachusetts)	Study of SIS in outflow regions.

E. VLA OBSERVING PROGRAMS

The following 147 reserch programs were conducted with the VLA during the quarter.

No.	Observer(s)	Program
AA-73	Akujor, C. (Nigeria)	PKS 0114+ 074. 6, 20 and 90 cm.
AA-93	Alexander, P. (MRAO) Sopp, H. (MRAO) Pooley, G. (MRAO)	Active nuclei in star-forming galaxies. 20 cm.

No.	Observer(s)	Program
AA-95	Alexander, P. (MRAO) Pooley, G. (MRAO) Sopp, H. (MRAO)	Circum-nuclear star formation in ultra-luminous galaxies. 2, 6, 20 and 90 cm.
AA-96	Anantharamaiah, K. Cornwell, T. Narayan, R. (Steward Obs.)	Synthesis imaging of sources scatter-broadened through the solar wind. 2, 3.5, 6 and 20 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring the radio flux of HD193793 and P Cygni. 2 and 6 cm.
AB-440	Brown, R.	The extended structure of 0235+164. 18 and 20 cm.
AB-456	Burke, B. (MIT) Hewitt, J. (Princeton) Roberts, D. (Brandeis)	Time variation of 0957+561. 6 cm.
AB-457	Brown, A. (Colorado) Bookbinder, J. (Colorado)	Distance to the Taurus-Auriga star formation region. 6 cm.
AB-473	Burns, J. (New Mexico) Gisler, G. (Los Alamos) Borovsky, J. (Los Alamos) Baker, D. (NASA) Zeilik, M. (New Mexico)	VLA observations of the planet Mercury. 2 and 6 cm.
AB-489	Barvainis, R. (Haystack) Antonucci, R. (STScI)	A new continuum component in radio quiet quasars. 1.3, 2, 6, and 20 cm.
AB-492	Bloeman, J. (Leiden) Duric, N. (New Mexico)	Study of 4 edge-on galaxies. 90 cm.
AB-501	Benz, A. (Inst. Ast. ETH) Catala, C. (Meudon) Praderie, F. (Meudon)	Search for radio emission in three Ae/Be Herbig stars. 3.6 and 6 cm.
AB-511	Baum, S. (NFRA) Chambers, K. (Johns Hopkins) Miley, G. (Leiden)	A search for HI absorption in a radio galaxy at z = 3.395. 90 cm line.
AB-512	Barthel, P. (Kapteyn Lab) Coleman, P. (Kapteyn Lab)	Radio morphology of the BAL quasar PG1700+518. 2 and 6 cm.
AB-513	Becker, R. (Calif., Davis) White, R. L. (STScI) Helfand, D. (Columbia) Zoonematkermani, S. (Columbia)	A search for stellar wind sources and ultracompact HII regions. 6 and 20 cm.

No.	Observer(s)	Program
AB-515	Becker, R. (Calif., Davis) Helfand, D. (Columbia) Zoonematkermani, S. (Columbia) White, R. (STScI)	Weak extended galactic sources. 6 and 20 cm.
AB-516	Brown, R.	Ionized gas in the z = 0.473 absorption region toward 3C 196. 3.5 and 6 cm.
AB-518	Baudry, A. (Bordeaux) Diamond, P.	Mapping the OH masers near the starburst nucleus of M82. 18 cm line.
AB-521	Bowers, P. (NRL) Johnston, K. (NRL) de Vegt, C. (Hamburg)	Absolute positions and structure of circumstellar water masers. 1.3 cm line.
AB-537	Baudry, A. (Bordeaux) Brouillet, N. (Bordeaux) Henkel, C. (MPIR, Bonn) Jacq, T. (MPIR, Bonn)	H_2O maser in M82. 1.3 cm.
AC-187	Campbell, B. (New Mexico) Simon, M. (SUNY)	Outflow young stellar objects. 2 and 6 cm.
AC-209	Cohen, R. (NRAL) Chapman, J. (NRAL) Saikia, D. (NRAL)	Circumstellar masers. 1.3 and 18 cm line.
AC-224	Caillault, J. (Georgia) Patterson, J. (Columbia) Skillman, D. (NASA)	The radio light curve of V471 Tauri. 6 and 20 cm.
AC-230	Comins, N. (Maine) Owen, F.	3C 442. 90 cm.
AC-233	Chlebowski, T. (Warsaw) Churchwell, E. (MPIR/Wisconsin)	A search for radio continuum emission from massive, X-ray luminous O-stars. 6 cm.
AC-234	Chambers, K. (STScI) Miley, G. (Leiden) van Breugel, W. (Berkeley)	Study of radio galaxies with z > 2. 6 and 20 cm.
AC-236	Cordova, F. (Los Alamos) Hjellming, R.	A coordinated, multi-wavelength campaign on Cygnus X-2 from X-ray to radio wavelengths. 2, 3.6, 6, and 20 cm.

No.	Observer(s)	Program
AC-238	Cotton, W. Bridle, A. Perley, R. Carilli, C. (MIT) Laing, R. (RGO) Walker, R. C.	Hotspot complexes at 0."1 resolution. 3.6 cm. Three antenna VLB.
AC-239	Crane, P. Bash, F. (Texas) Kaufman, M. (Ohio State)	Structure in the nucleus of M81. 20 cm.
AC-241	Campbell, B. (New Mexico) Stocke, J. (Colorado)	Inner disk and jet structure in L1551 IRS 5. 1.3, 2, 6 and 20 cm.
AC-242	Claussen, M. (NRL) Bowers, P. (NRL) Johnston, K. (NRL) Gaume, R. (NRL)	Interferometric stokes polarimetry of the OH maser emission from late-type stars. 18 cm line.
AC-243	Condon, J.	Compact components in nearby radio galaxies. 20 cm.
AD-188	Drake, S. (SASC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in M supergiant Alpha Ori. 2 and 6 cm.
AD-205	de Pater, I. (Berkeley)	Jupiter at 327 MHz. 90 cm.
AD-217	Drake, S. (SASC) Caillault, J. (Georgia)	Radio emission in the spotted BY Draconis stars. 6 cm.
AD-222	de Pater, I. (Berkeley) Gulkis, S. (JPL) Romani, P. (NASA) Atreya, S. (Michigan)	Uranus. 6 and 20 cm.
AD-224	Drake, S. (SASC) Bastian, T. Linsky, J. (Colorado)	Helium-weak magnetic stars in Sco-Cen. 2, 3.5, and 6 cm.
AD-225	Diamond, P. Goss, W. M.	Magnetic field structure in the envelopes of supergiant stars. 18 cm line.

No.	Observer(s)	Program
AD-226	Duric, N. (New Mexico) Gregory, P. (British Columbia)	Core-variable radio sources. 6 and 20 cm.
AE-55	Ekers, R. (CSIRO) Cowan, J. (CFA) Sramek, R. (CSIRO) Goss, W. M. Roberts, D. (Oklahoma)	Young SNR G25.52+0.22. 6, 20 and 90 cm.
AE-59	Elvis, M. (CFA) Bechtold, J. (Arizona)	Limits on Galaxy disk sizes at Z -> 0.5. 6 and 20 cm.
AF-151	Frail, D. (Toronto) Cordes, J. (Cornell) Hankins, T. (NMIMT) Weisburg, J. (Carleton) Seaquist, E. (Toronto)	Neutral hydrogen absorption measurements of distant pulsars in the inner galaxy. 20 cm line.
AF-163	Feretti, L. (Bologna) Giovannini, G. (Bologna)	Cluster radio galaxies of small size. 20 cm.
AF-166	Foster, R. (Berkeley) Backer, D. (Berkeley) Wolszczan, A. (NAIC)	Pulsar PSR 1951+32 in SNR CTB 80. 20 cm.
AF-168	Fruchter, A. (Princeton) Stinebring, D. (Princeton) Taylor, J. (Princeton) Goss, W. M.	Observation of the eclipsing millisecond pulsar. 20 and 90 cm.
AG-255	Gwinn, C. (CFA) Birkinshaw, M. (CFA) Fieldler, R. (NRL) Dennison, B. (NRL) Simon, R. (NRL)	Search for host structures of extreme scattering events. 6 and 90 cm.
AG-273	Ge, J-P. (NMIMT) Owen, F.	Rotation measure in A1795. 3.6 cm.
AG-276	Greenhill, L. (CFA) Moran, J. (CFA) Reid, M. (CFA)	HII regions with H_2O masers in M33. 1.3, 2, 3.6, 6 and 20 cm.
AH-293	Hanisch, R. (STScI) Miley, G. (Leiden)	The rich X-ray cluster Abell 2256. 90 cm.

No.	Observer(s)	Program
AH-295	Habing, H. (Leiden) Goss, W. M. Winnberg, A. (Onsala) van Langevelde, H. (Leiden)	Monitoring galactic center OH/IR stars. 18 cm line.
AH-301	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Systemic observations of two new radio novae. 1.3, 2, 3.6, 6, and 20 cm.
AH-328	Heflin, M. (MIT) Lehar, J. (MIT) Burke, B. (MIT) Langston, G. (NRL)	Third image near 2016+112C. 1.3 cm.
AH-329	Hughes, V. (Queen's Univ.) MacLeod, G. (Queen's Univ.)	Star formation in very dense regions. 2, 6, and 20 cm.
AH-330	Hughes, V. (Queen's Univ.)	Variability of HII regions in Cepheus A. 2, 6, and 20 cm.
AH-334	Hewitt, J. (Haystack) Perley, R. Turner, E. (Princeton)	The twin galaxies of the 0249-186 field. 20 cm.
AH-335	Hewitt, J. (Haystack) Burke, B. (MIT) Turner, E. (Princeton)	Variability in MG1131+0456. 2, 3.5 and 6 cm.
AH-337	Hankins, T. (NMIMT) Horton, E. (Dartmouth)	Measurements of the Crab pulsars average profile. 6 and 18 cm.
AH-339	Haschick, A. (Haystack) Ho, P. (CFA) Rodriguez, L. (CFA)	A new position determination for the H_2O maser associated with HH1-2. 1.3 cm line.
AJ-168	Jones, D. (JPL) Gwinn, C. (CFA) Linfield, R. (JPL) Dewey, R. (JPL) Davis, M. (NAIC)	VLBI astrometry of PSR 1937+214. 18 cm phased array VLB.
AK-200	Keto, E. (Livermore Labs) Carral, P. (Berkeley) Welch, W. (Berkeley) Reid, M. (CFA) Ho, P. (CFA)	Structure of recombination line emission in ultracompact HII regions. 3.6 cm line.

No.	Observer(s)	Program
AK-210	Kulkarni, S. (Caltech) Wolszczan, A. (NAIC) Middleditch, J. (Los Alamos) Backer, D. (Berkeley) Fruchter, A. (Princeton)	Astrometry of the pulsar in the Globular cluster M15. 20 cm.
AK-211	Kapahi, V. (JPL) Hough, D. (JPL)	Jets in misaligned quasars. 2 and 6 cm.
AK-212	Kirkpatrick, H. (Maryland) Wilson, A. (Maryland) Heckman, T. (Maryland)	Star formation and nuclear activity in Seyfert galaxies. 6 and 20 cm.
AK-213	Kwok, S. (Calgary) Aaquist, O. (Calgary)	Compact planetary nebulae. 2 and 6 cm.
AL-146	Leahy, J. Perley, R.	Bridges in nearby 3C sources. 20 cm.
AL-150	Lestrade, J. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.
AL-185	te Lintel Hekkert, P. (Leiden) Likkel, L. (UCLA) Zijlstra, A. (Kapteyn Lab) Pottasch, S. (Kapteyn Lab) Caswell, J. (CSIRO) Habing, H. (Leiden)	OH and H_2O line observations of irregular OH/Ir stars and young planetary nebulae. 1.3 and 18 cm line.
AL-188	Langston, G. (NRL) Heflin, M. (MIT) Lehar, J. (MIT) Burke, B. (MIT) Lawrence, C. (Caltech)	Variation of 2016+112, probable lens source. 2 and 6 cm.
AL-198	Lestrade, J. (JPL) Preston, R. (JPL)	Astrometry of UX Ari, Sigma CrB. 6 cm single antenna VLB.
AM-178	Mutel, R. (Iowa) Gopal-Krishna (TIFR)	Compact double sources. 20 cm line.
AM-227	Maccacaro, T. (CFA) Gioia, I. (CFA) Wolter, A. (CFA) Stocke, J. (Colorado) Morris, S. (Mt. Wilson)	Extragalactic component of the extended medium sensitivity survey: an extension to the south. 6 cm.
AM-235	Masson, C. (Caltech) Keene, J. (Caltech)	Search for dense gas around young stars. 1.3 cm line.

No.	Observer(s)	Program
AM-238	Muhleman, D. (Caltech) Grossman, A. (Caltech) Thompson, T. (JPL) Goldstein, R. (JPL)	Radar imaging of Mars. 3.5 cm.
AM-241	Miley, G. (Leiden) Chambers, K. (Johns Hopkins)	A survey of ultra-steep spectrum Texas sources. 20 cm.
AM-248	Menten, K. (CFA) Walmsley, C. (MPIR, Bonn) Schilke, P. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Gaume, R. (NRL) Johnston, K. (NRL)	Methanol masers. 1.3 cm line.
AM-249	Miley, G. (Leiden) Chambers, K. (Johns Hopkins) Rottgering, H. (Leiden)	A survey of ultra-steep spectrum Parkes sources. 20 cm.
AM-250	Mangum, J. (Virginia) Wootten, H. A.	OH and H_2O masers in the pre-stellar condensations of DR21 (OH). 1.3 and 20 cm line.
AM-252	Mollenhoff, C. (Heidelberg) Bender, R. (Heidelberg) Hummel, E. (NRAL)	Dust-lane ellipticals. 20 cm.
AM-254	Mirabel, I. (Caltech) Sanders, D. (Caltech) Dickey, J. (Minnesota) Kazes, I. (Meudon)	HI and OH in ultraluminous infrared galaxies. 18 and 20 cm line.
AM-255	Mirabel, I. (Caltech) Sanders, D. (Caltech) Dickey, J. (Minnesota) Kazes, I. (Meudon)	HI absorption and OH emission in the ultraluminous infrared radio galaxy PKS 1345+125. 18 and 20 cm line.
AM-256	Migenes, V. (Pennsylvania) Johnston, K. (NRL) Wilson, T. (MPIR, Bonn)	The kinematics of Orion-OMC-1. 1.3 cm line.
AM-257	Mutel, R. (Iowa) Morris, D. (Iowa)	RS CVn Stars: frequency dependence of polarization. 2, 3.6, 6, 18 and 20 cm line.
AM-260	Menten, K. (CFA) Reid, M. (CFA)	Methanol masers in the NGC 6334-F region. 1.3 cm line.

No.	Observer(s)	Program
AM-261	Moran, J. (CFA) Rodriguez, L. (CFA) Scalise, E. (CRAAM)	Very luminous H_2O maser associated with GGD25. 1.3 cm line.
AN-47	Neff, S. (NASA) Hutchings, J. (DAO) Gower, A. (Victoria)	Radio evolution of high redshift radio quasars. 6 and 20 cm.
AN-48	Neff, S. (NASA) Hutchings, J. (DAO)	Multiple nucleus active galaxies. 1.3, 2, 3.5, and 6 cm.
AO-84	O'Dea, C. (NFRA) Baum, S. (NFRA)	Radio properties of giant galaxies in cooling flows. 90 cm.
AP-138	Pedlar, A. (NRAL) Anantharamaiah, K. van Gorkom, J. (Columbia) Ekers, R. (CSIRO)	Continuum and recombination lines towards the galactic center. 90 cm line.
AP-166	Pottasch, S. (Kapteyn Lab) Zijlstra, A. (Kapteyn Lab) Ratag, M. (Kapteyn Lab) Bignell, R. C.	Very young planetary nebulae. 2 and 6 cm.
AP-168	Pedlar, A. (NRAL) Anantharamaiah, K. Goss, W. M. van Gorkom, J. (Columbia) Ekers, R. (CSIRO)	Galactic center. 90 cm.
AR-168	Rusk, R. (Toronto)	Radio polarimetry of 1807+698 (3C 371). 1.3, 2, 6, and 18 cm.
AR-182	Rodriguez, L. (CFA) Hartmann, L. (CFA)	Radio continuum from FU Ori stars. 6 cm.
AR-189	Rudy, D. (UCLA) Berge, G. (Caltech) Muhleman, D. (Caltech)	Latitudinally varying brightness temperature on Mars. 6 and 20 cm.
AR-190	Rafanelli, P. (Padova) Marziani, P. (ISAS) Gregorini, L. (Bologna) Padrielli, L. (Bologna)	Nuclear environment of Seyfert galaxies. 6 and 20 cm.
AR-191	Riley, J. (MRAO) Warner, P. (MRAO)	The radio core of the largest-known quasar 4C 74.26. 2, 3.5, 6, 20, and 90 cm.

No.	Observer(s)	Program
AR-192	Rodriguez, L. (CFA) Bastian, T.	Radio recombination line radiation from MWC 349. 3.6 cm line.
AR-193	Rodriguez, L. (CFA) Mirabel, I. F. (Caltech) Roth, M. (Chile)	Positions of the H_2O and OH masers possibly associated with a peculiar triple source in Serpens. 1.3, and 20 cm line.
AR-200	Reynolds, S. (NC State)	Small-scale structure in young supernova remnants. 90 cm.
AR-201	Rodriguez, L. (CFA) Ho, P. (CFA) Curiel, S. (UNAM) Torrelles, J. (IAA) Canto, J. (UNAM)	Central source of the HH1-2 system. 20 cm.
AS-319	Simon, R. (NRL) Fiedler, R. (NRL) Dennison, B. (NRL/VPI) Johnston, K. (NRL) Spencer, J. (NRL)	Extreme scattering events in the interstellar medium. 6, 20, and 90 cm.
AS-331	Sahai, R. (Chalmers) Claussen, M. (NRL)	The enigmatic radio source in IRC+10216. 1.3, 2, and 3.5 cm.
AS-333	Sramek, R. (CSIRO) Weiler, K. (NRL) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6, and 20 cm.
AS-339	Sramek, R. (CSIRO) Goss, W. M. Cowan, J. (Oklahoma)	A search for radio emission from supernovae 1909A and 1970G in M101. 20 cm.
AS-348	Skinner, S. (Colorado) Bookbinder, J. (CFA) Fleming, T. (Arizona) Linsky, J. (Colorado) Stocke, J. (Colorado)	The stellar component of the Einstein medium sensitivity survey: the lower main sequence. 6 cm.
AS-352	Smith, H. (NRL) Fischer, J. (NRL) Schwartz, P. (NRL) Mozurkewich, D. (NRL)	Outflows from CO/IR selected IRAS sources. 6 and 20 cm.
AS-355	Sumi, D. (Illinois) Burns, J. (New Mexico) Zhao, J-H. (New Mexico)	3C 317, the central galaxy in the cooling flow cluster Abell 2052. 6, 20 and 90 cm.

No.	Observer(s)	Program
AS-360	Schwartz, P. (NRL) Johnston, K. (NRL) deVegt, C. (Hamburger Sternwarte)	Precise radio positions and flux densitites of T Tau N and S. 2, 6, and 20 cm.
AS-364	Singh, K. (TIFR) Westergaard, N. (DSRI)	Simultaneous monitoring of radio and X-ray emission from Markarian 509. 6 and 20 cm.
AT-94	Taylor, A. (Calgary) Seaquist, E. (Toronto) Kenyon, S. (CFA)	Continued monitoring of the Symbiotic stars Z and CH Cyg. 1.3, 2, 6, and 20 cm.
AT-95	Terzian, Y. (Cornell) Bignell, R. C. van Gorkom, J. (Columbia) Phillips, T. (Cornell)	Angular expansion of planetary nebulae-Epoch II. 6 cm.
AT-98	Turner, J. (UCLA) Ho, P. (Harvard)	Supernova remnants and supernovae in normal spiral galaxies. 6 cm line.
AV-153	van Breugel, W. (Berkeley) McCarty, P. (Berkeley) Spinrad, H. (Berkeley)	High redshift radio galaxies with extended optical line emission. 6 and 20 cm.
AV-157	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Lilly, S. (Hawaii) Spinrad, H. (Berkeley)	Multifrequency observations of B2; "Jansky" radio sources. 3.5, 6, and 20 cm.
AV-161	Velusamy, T. (TIFR)	Jet, filaments, and outer structure of the Crab nebula. 90 cm.
AV-162	van Breugel, W. (Berkeley) Shields, J. (Berkeley)	Radio loud, far-infrared galaxies. 20 cm.
AW-193	White, S. (Maryland) Kundu, M. (Maryland) Jackson, P. (Maryland)	Narrow-band flaring on red dwarf stars. 6 and 20 cm.
AW-209	White, S. (Maryland) Kundu, M. (Maryland)	Flare stars. 20 and 90 cm.
AW-220	Willson, R. (Tufts) Lang, K. (Tufts)	Dynamic spectra bursts from active stars. 20 and 90 cm line.

No.	Observer(s)	Program
AW-223	Wehrle, A. (Caltech) Crane, P.	Bubbles in NGC 2992. 3.5 and 6 cm.
AW-227	White, S. (Maryland) Kundu, M. (Maryland) Agrawal, P. (TIFR)	X-ray emitting dM stars. 6 and 20 cm.
AW-228	Wrobel, J. (NMIMT) Briggs, D. (NMIMT) Bridle, A. Leahy, J. Walker, R. C. Laing, R. (RGO)	Proper motions of a knot in the side-on jets of M84. 6 cm.
AW-229	Wilson, T. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Johnston, K. (NRL)	Precise position and distribution of the NH_3 masers associated with W3(OH). 1.3 cm line.
AW-230	Wrobel, J. (NMIMT) Unger, S. (RGO)	Monitoring of the Seyfert NGC 5548. 3.5 cm.
AY-22	Yun, M. (CFA) Ho, P. (CFA) Lo, K. (Illinois)	HI synthesis mapping of M82. 21 cm line.
AY-27	Yusef-Zadeh, F. (NASA)	Orientation of the magnetic field near the galactic center. 3.5 and 6 cm.
AZ-39	Zhao, J-H. (New Mexico) Ekers, R. (CSIRO) Goss, W. M. Price, R. (New Mexico) Lo, K. (Illinois)	Monitoring long-term flux-variations of Sgr A at multi-wavelengths. 1.3, 2, 3.5, 6, 18, and 20 cm.
AZ-40	Zlobeck, P. (Trieste Obs.) Messerotti, M. (Trieste Obs.) Dulk, G. (Colorado) Bastian, T. Bookbinder, J. (Colorado)	High resolution studies of the sun and Type I bursts. 90 cm.
AZ-41	Zell, P. (Iowa) Fix, J. (Iowa)	Polarization maps of two OH masers. 18 cm line.
VA-21	Alef, W. (MPIR, Bonn) Preuss, E. (MPIR, Bonn) Kellermann, K.	The core of 3C 147. 3.6 cm phased array VLB.
VAH-40	Kus, A. (Copernicus Univ.) Porcas, R. (MPIR, Bonn)	3C 309.1. 3.6 cm phased array VLB.

No.	Observer(s)	Program
VH-43	Hough, D. (JPL) Zensus, A. Porcas, R. (MPIR, Bonn) Readhead, A. (Caltech)	Survey of weak nuclei in double lobed quasars. 3.8 cm phased array VLB.
VH-44	Hewitt, J. (Princeton) Bookbinder, J. (CFA) Capallo, R. (Haystack) Corey, B. (Haystack) Hinteregger, H. (Haystack) Lestrade, J. (Paris) Lonsdale, C. (Haystack) Niell, A. (JPL) Phillips, R. (Haystack) Preston, R. (JPL)	dMe stars. 3.6 cm phased array MK III VLB.

F. SCIENTIFIC HIGHLIGHTS

Carbon Monoxide Emission at High Redshift

Using the high-performance receiving systems at the 12-m, observers are reaching sensitivities and frequency bands never before available on a routine basis. These capabilities have resulted in a significant expansion of astronomical research areas. For example, detections have recently been reported of carbon monoxide emission from the distant quasar Mrk 1014 and the powerful radio galaxy Perseus A (3C 84). The 12-m observations indicate large amounts of molecular gas in the quasars. This gas may provide the fuel for the high luminosity output of quasars, thus explaining one of the chief enigmas of modern astronomy.

Investigators: I. F. Mirabel (Puerto Rico), D. B. Sanders (Caltech), I. Kazes (Observatoire de Paris)

Submillimeter Spectral Survey

A continuous spectral line survey of the galactic molecular cloud Orion A has been completed in the 330-360 GHz (0.91- 0.83 mm) range using the 12-m. This is the first complete spectral line survey in this range ever published. Over 180 spectral lines were detected. The 12-m is the first telescope to have a sensitive receiving system in this band that is available on a routine, annual basis.

Investigators: P. Jewell (NRAO), L. Snyder (Illinois), J. M. Hollis (NASA/GSFC)

Most Powerful Megamaser Ever?

OH maser emission from the infrared-luminous powerful radio galaxy 4C 12.50 (=PKS 1345+125) has been detected with the VLA at a redshifted velocity of 36,600 k/s. The galaxy radiates as strongly in the infrared as the well known ultraluminous infrared galaxy Arp 220 and is known from recent CO (1-0) observations to have emission indicative of the presence of 4.7×10^{10} $M_\odot$ of molecular gas. In the optical its double nucleus has been interpreted as a Seyfert nucleus merging with a giant elliptical cD at the center of a cluster. Strong HI absorption toward the nucleus has also been seen with Arecibo and the VLA, but the most exciting results come from the OH emission where the isotropic luminosity of the two main lines at 1665 and 1667 MHz is a whopping 2500 $L_\odot$--possibly the most powerful megamaser discovered to date.

Investigators: I. F. Mirabel (U. Puerto Rico), D. B. Sanders (Caltech), J. Dickey (Minnesota), I. Kazes (Observatoire de Paris)

High Dynamic Range Solar Imaging

As part of an ambitious program of microwave, X-ray, and optical observations of the Sun during the IAU International Solar Month, bandwidth synthesis techniques were employed to image the Sun at 3.6, 6, 20, and 90 cm on four consecutive days with the VLA. The observing program was designed to follow the temporal evolution of the microwave emission from solar active regions where strong magnetic fields have erupted through the photosphere, forming an ensemble of coronal magnetic loops which are anchored in sunspots. Active regions are associated with most forms of transient solar activity, e.g., flares, noise storms, filament eruptions, coronal transients, etc.

The program has resulted in the most comprehensive and detailed view of microwave emission from active regions yet obtained. The technique of bandwidth synthesis yielded images at each wavelength of unprecedented dynamic range--several hundred to one in many cases, more than an order of magnitude greater than previous microwave images of solar active regions.

The wealth of detail revealed by these high dynamic range images has produced at least one surprise already. At 3.6 cm (the VLA's new X band systems), faint thermal emission from dense, low-lying magnetic loops has been imaged for the first time. Preliminary analysis at this and other wavelengths shows that the details of the microwave emission from active regions do indeed change considerably in time. The reasons for these changes include the emergence of new magnetic flux, the motion of the footpoints of the loops which comprise the active region, episodes of localized heating, or catastrophic events (flares, filament eruptions, coronal transients) that lead to a global reordering of the magnetic field. Which of these possibilities is relevant awaits further analysis and modeling of the data.

Investigators: T. Bastian, R. Gonzales, T. Cornwell (NRAO), S. Habbal (CFA), G. Dulk (Colorado)

Mars Radar Imaging

The VLA has been used to develop a new planetary radar technique that images an entire planet in periods shorter than one hour. The VLA synthetic aperture radar technique was successfully demonstrated in earlier mapping of the radar echo from Saturn. Recent observations of Mars, however, benefitted from the almost full complement of X-band receivers (26 antennas) and the fact that Mars was near opposition. Mars was illuminated with the 350 kW JPL/NASA Goldstone radar at 8.5 GHz and the 26 kHz Doppler-spread echo power was observed with spectral line mode (64 channels) and 10 minute snapshots. Resultant CLEANED channel maps image an area of the planet defined by the Doppler strip for that channel. The merged channel maps provide a complete image of Mars.

So far the Martian maps have only made use of the diffusely scattered depolarized echo power, but there are at least five distinct regions where this component is anomalously strong: the south residual polar ice cap, the entire Tharsis region, the shields of the three major Tharsis volcanoes, southeast of Olympus Mons, and southeast of Elysium Mons. Analogies with the radar properties of other solar system bodies await a more sophisticated treatment of the specular radar reflection.

Investigators: D. O. Muhleman, W. W. Grossman, B. Butler (Caltech), M. Slade, R. Jurgens (JPL)

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. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

During this quarter all the spare parts specified in the NASA/JPL Management Plan for support of the Voyager receivers have been shipped to the VLA site.

Cooled HEMT Amplifier Development

During this quarter a total of nine more 22 GHz amplifiers have been built for the VLA and VLBA projects. Further production is contingent on receiving more HEMT devices from Mitsubishi.

Also during this quarter a total of eight L-band amplifiers have had HEMT devices installed. After meeting Green Bank, VLBA, and Tucson needs, two units remain as spares.

A prototype broadband amplifier for the frequency range 8-18 GHz has been tested at room temperature and will be cold tested at the beginning of the next quarter. The room temperature tests gave a noise temperature of less than 200 K between 8 and 18 GHz, with gain in the range 19-25 dB. The plan is to build a series of broadband amplifiers for the 140-ft telescope. Their frequency responses will be tailored to match the feeds used to cover the 5-18 GHz frequency range.

The development of the four-stage 43 GHz amplifier for the VLBA project has been continuing. This quarter we have been evaluating devices from four manufacturers. It seems likely that we can purchase devices from two of these sources for use in VLBA amplifiers. Over the next few months we plan to build a production version of this amplifier which can be reproduced for the VLBA receivers.

Superconducting (SIS) Millimeter-Wave Mixer Development

We have continued evaluating several wafers of Nb/Al-Al2O3/Nb trilayer SIS mixers made to our design by Hypres. After difficulties with poor quality junctions and peeling conductors on the first two wafers, we have found a number of usable devices on the third wafer. Included on this mask-set are 115 GHz and 230 GHz mixers with integrated tuning circuits, and some experimental, fully integrated mixers which require no external tuners. Very encouraging results have been obtained with the fully integrated mixer: with no mechanical tuning at all, the receiver noise temperature T_r < 90 K DSB (referred to the mixer input flange) from 70-115 GHz, and T_r < 55 K over 83-115 GHz. It should be emphasized that these are initial results on a prototype mixer, and that one or two more iterations of the design over the next 12-18 months will probably be needed before we can expect to install such fixed-tuned mixers on telescope systems. All the mixers on this third Hypres wafer appear to have a conversion loss 5-10 dB higher than expected, regardless of LO frequency; this may be associated with the peculiar brown/orange appearance of the Nb interconnection layer. The Hypres mixers are fabricated under a no-cost collaborative agreement with NRAO. The seven masks for this process were laid out using the UVA mask design facilities.

The 90 GHz mixer supplied to Dr. P. Lubin at the University of California, Santa Barbara for cosmic background studies is now in use at the South Pole. Using a low-loss quasi-optical input, a receiver noise temperature of 33 K DSB was obtained. This mixer uses one of our older Hypres junctions without an integrated tuning structure.

Our millimeter-wave research collaboration with IBM Watson Research Center continues. A new set of SIS mixers for 115 and 230 GHz has been designed for fabrication by IBM using their Nb/Nb_2O_5/Pb-In-Au edge-junction process. Using junctions of this kind we have obtained mixer noise temperatures < 6 K DSB in the 85-116 GHz range. Two of these mixers are now operating on the 12-m telescope at Kitt Peak. Because of its high input loss, the noise temperature of the telescope receiver is relatively high: 74 K to 138 K SSB in the better channel, and about 20 K higher in the other channel. We supplied one of these mixers to the Harvard/ Smithsonian Sky Survey Telescope which now has an overall receiver noise temperature of 34 K in DSB operation and 52 K when tuned for SSB operation.

The $Nb/Al\text{-}Al_2O_3/Nb$ trilayer process (similar to that of Hypres) for fabricating superconducting circuits appears to be the best available for millimeter-wave SIS mixers. This process is being implemented at UVA as part of a collaborative effort with NRAO to develop better SIS mixers. We expect the UVA collaboration to give us the responsive source of SIS junctions we need to develop mixers for other frequency bands and to explore fully integrated mixer structures (such as that described above) and quasi-optical mixers (e.g., the Phillips planar-spiral mixer) without the great cost and delays of using a commercial source of junctions. Recent UVA junctions have had the highest quality parameter V_m ever reported.

During this quarter we have tested a total of 18 SIS mixers operating from 70-260 GHz.

Schottky Diode Millimeter-Wave Mixer Development

In support of the 12-m telescope this quarter we have built (or re-built) and tested a total of 17 Schottky mixers and multipliers in the 230, 300, and 345 GHz bands.

I. GREEN BANK ELECTRONICS

Spectral Processor

The digital section for one 1024 channel spectrometer was assembled and successfully tested this quarter. Some spurious signals in the spectral output were observed and efforts were made to locate and correct the causes. Most appeared to be associated with the A/D converter boards (purchased commercially). The output levels were reduced significantly by improving the shielding and power supply decoupling. It is felt that the spurious levels are now acceptable; if found otherwise during later system use, the A/D boards will probably require redesign. Work continues on the hardware and software interface between the digital rack and the Spectral Processor control computer. It is expected that integration tests with the two will begin in the next quarter. Construction of the second spectrometer will now proceed; most of the required boards have been shipped for wirewrapping.

The collapse of the 300-ft has of course caused revision of the plans for use of the Spectral Processor. It has been decided to install it at the 140-ft and the problems associated with doing so are under examination.

140-ft Telescope Cassegrain Receivers

The current 140-ft cassegrain receiver systems use parametric upconverters and 18-25 GHz masers to cover the 5-25 GHz frequency range. A project is underway to replace the upconverters with HEMT amplifiers and to also extend the frequency range to greater than 30 GHz. The masers will be retained because of their significantly superior noise performance over current HEMT technology. A prototype 32 GHz room-temperture mixer receiver was assembled this quarter. This receiver will be installed on the 140-ft and aperture efficiency measurements will be attempted this winter in order to determine the highest useful frequency of the telescope. Refrigerators for the HEMT dewars were ordered and the dewar design will begin in earnest during the next quarter.

S/X Receivers

The USNO is funding the design and construction of new cryogenic receivers for the Green Bank three-element interferometer. The 85-3 telescope will be operated as a VLBI terminal in conjunction with other USNO antennas. The 85-1 and 85-2 telescopes will be operated as a connected interferometer to continue a long-term flux monitoring program.

During this quarter, the first cryogenic receiver was completed and installed on 85-3 and the telescope was operated under control of the new control computer. System temperatures at both X-band and S-band averaged 38 Kelvin. Aperture efficiency at X-band averaged 36 percent and at S-band 52 percent.

Because the USNO could not supply a VLBI record terminal to use at 85-3, NRAO agreed to use the MK III terminal located at the 140-ft. This necessitated a broadband link between the two telescopes which is being implemented with a buried single-mode optical fiber. This link is the major technical problem that remains. Field splices are required in the optical fiber and mechanical splices were attempted. These were found to have excessive loss. A contract has now been let with a firm that will do field fusion splices that should meet the loss requirements.

Work began on components needed for the next receivers.

Miscellaneous

Ten 4.8 GHz cooled HEMT amplifiers were completed this quarter, completing the number required for the VLA receiver upgrade project. Work commenced on HEMT amplifiers needed to upgrade the 7-feed receiver. This receiver was on the 300-ft when it collapsed, and sustained minor damage inside the dewar. While the system is disassembled for repair, we will replace the three-year old FET amplifiers with HEMT amplifiers that should have noise temperatures lower by about 10 Kelvin.

S/N 7 VLBA 4.8 GHz front-end was completed and tested, and S/N 7 VLBA 1.5 GHz front-end was assembled. A problem was encountered with one cooled 1.5 GHz amplifier. That amplifier was removed for rework.

Eight VLBA 2-16 GHz synthesizers (through S/N 22) were assembled this year. These only lack monitor/control interface cards for final alignment. Work commenced on the twelve units scheduled for completion in 1989.

J. 12-M ELECTRONICS

Receiver Status

70-115 GHz Schottky Mixer Receiver - The high frequency dewars on this receiver (90-115 GHz) have been dismantled as this frequency range is now covered by the SIS receiver. Our intention is to cover both the 70-90 GHz and 90-115 GHz frequency ranges with a new SIS receiver within the next year. This will allow us to remove the Schottky receiver from service entirely.

200-360 GHz Schottky Mixer Receiver - This dual channel receiver is unchanged since the last report.

90-115 GHz SIS Receiver - There have been various problems with this receiver during the last quarter. On several occasions there have been problems with the refrigerator system that have resulted in several days down time. It seems that these problems resulted from a faulty refrigerator that has now been replaced.

Another problem that has surfaced with spectral lines observations at the millikelvin level has been the presence of low level ripples in the output of the spectrometer, particularly when observing sources with an appreciable continuum level. A major contributor to this problem was found to be an imperfect termination in the polarization diplexer. This was fixed and, as far as we can tell, the problem has been greatly reduced.

Eight-Beam 230 GHz Receiver - This receiver is complete and is awaiting the completion of the hybrid spectrometer.

Hybrid Spectrometer - We have badly underestimated the amount of work needed to bring this instrument to completion. The hardware is now fully complete and the software is at the point of displaying spectra in a rudimentary way. The major remaining tasks are to clean up the system and to interface the instrument to the VAX at the 12-m telescope. It seems virtually certain that we will be testing the spectrometer on the telescope in the next three months. The problems that these tests may unveil and the difficulties that may result in the interfacing of the instrument make it extremely difficult to give a firm date for the availability of the system to observers.

Next Generation SIS Receivers - Work continues in Charlottesville, Green Bank and Tucson on the next generation of SIS receivers. We hope to have receivers to cover the 70-115 frequency range and the 200-260 GHz range within the next year.

K. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam, and pointing errors then limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beam width so the source being imaged is affected directly. For example, at 44 GHz a 20" pointing error causes a 30 percent change in amplitude. Solar-induced tilts, which used to dominate our pointing errors have been greatly reduced through external insulation of the antenna yoke and base support.

An important pointing problem which is being investigated now 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 believed to be caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Testing of the stability of two redesigned tilt-meter units showed that the temperature control of the tiltmeter meter unit is now adequate and the components for several more tilt-meter units are on order, with fabrication to start in the first quarter of 1989.

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 percent 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 catalog could be mapped at 75 MHz with the same resolution as the original 1400 MHz aperture synthesis catalog done at Cambridge. The cost of this outfitting is very modest.

Two new dipole feeds have been designed; one a crossed dipole type, the other a quad dipole type. The crossed dipole was chosen as the easiest to implement, and testing of this feed and its effect on other frequencies will continue into next quarter. With the new feed installed near the focus of the antenna, locally generated radio frequency interference became a significant problem (see RFI Improvements). Four antennas are equipped with the 75 MHz system. NRAO has an agreement with NRL for further outfitting. The first level of funding (for four more systems) has been received and components are being procured.

VLA 327 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 has been designed so that observations in the 300-340 MHz range can be made with an instantaneous bandwidth of approximately 12 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.

Twenty-seven antennas now have 327 MHz receivers installed, and this system is scheduled for completion by January, 1989. RFI enclosures for the vertex mounted "B" racks have been installed on four antennas to reduce local RFI (see RFI Improvements).

VLA 8-GHz Receivers

Feeds and front-ends covering the frequency range 8.0-8.8 GHz are being installed on the VLA primarily to augment the NASA/JPL DSN 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. The 8.4 GHz front-ends enabled the VLA to be used in a successful planetary radar experiment with the Goldstone transmitter. The NRAO Central Development Laboratory has developed this front-end which was using GaAs FET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers have been incorporated into these systems during this quarter.

All thirty 8.4 GHz front-ends have been received from the Central Development Laboratory in Charlottesville and nineteen have been installed on Antennas. Interferometer and phased-up sum measurements with these antennas on Voyager II have been completed with the appropriate signal-to-noise ratio. Other test programs are continuing.

JPL has provided funding for this project, and antennas being overhauled will be outfitted with X-band feed towers. Installation of the remaining X-band system will be completed in January, 1989. Other interfacing sub-systems are also in process, such as new analog sum units and computer control analog sum switching unit.

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 were investigated. A modification to allow the Monitor and Control system to free run eliminated most of the coherent RFI between antennas. However, the remainder still limits use of the 327 MHz system, so enclosing the radiating components with RFI shields is necessary.

Four prototype RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosures have not been procured due to an increase in cost by a factor of two. These RFI enclosures eliminate the remaining antenna-generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. A method to reduce this interference is being investigated. No progress has been made during the quarter.

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 radiometers 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 R.F. components for the water-vapor radiometers have been procured and are being assembled for testing. The project is manpower limited (no progress has been completed this quarter).

1.3 cm Receiver Upgrade

Many important ammonia line experiments, such as accretion disks, circumstellar material, distant star forming complexes, and extragalactic ammonia, will benefit from the upgrade in K-band performance. The projected improvement at 24 GHz by a factor of three means a tremendous boost in speed and sensitivity. Experiments will be ten times faster. Eight-hour experiments will then take less than one hour. Instead of one region per u-v track, approximately ten regions can be studied at once. This is a very significant step forward.

The extension of the frequency coverage to 25.1 GHz is of particular interest because of the (J,K) = (6,6) line of NH_3 Together with the (J,K) = (3,3) line at 23.9 GHz, this will offer a pair of transitions belonging to the ortho (K=3n) species of NH_3. Because of their different excitation and radiative lifetimes, the ortho and para species of NH_3 are independent of each other, and have been suggested to be representative of conditions at different ages for the molecular material. Hence those ortho lines are particularly important spectroscopic tools for understanding some of the underlying physics.

A new "A" Rack has been fabricated, including a revised dewar layout. This new dewar assembly will contain a new 1.3 cm GaAs FET amplifier or HEMT amplifier presently under development at the Central Development Laboratory. This amplifier will reduce the system temperature to 150 K and increase the bandwidth above and below the current bandwidth of 22.0-24.0 GHz. Also a 5 GHz GaAs FET being developed in the Green Bank Electronics Division will be used to replace present 5 GHz paramps. The new "A" Rack has been installed on twenty-one antennas, with completion scheduled by April, 1989. Twenty-four antennas have been equipped with this receiver upgrade and installation of the remaining systems are scheduled to be complete by the end of the second quarter, 1989.

1.3-1.7 GHz T_{sys} Improvements

HI imaging is the most important class of spectral line project at the VLA. The observation of HI in emission (either galactic or extragalactic) is almost always sensitivity limited, either because the HI has to be followed to the faint outermost regions of galaxies, or because more angular or frequency resolutions are desirable.

The VLA 18-21 cm wavelength feed currently has system temperatures of approximately 60 K. A significant fraction of this system temperature results from the need to locate all front-ends in the same cryogenic dewar. This results in longer input waveguide runs than would usually be required and prevents the polarization splitters from being cooled.

For example, using similar cryogenically cooled GaAs FET amplifiers as those used on the VLBA, it is predicted that the fully optimized receivers on the VLBA will have system noise temperatures of 29 K at 18-21 cm.

Although some effects, such as subreflector diffraction, will prevent VLA noise temperatures from ever being quite as low as these VLBA values, it does seem worthwhile to investigate the possibility of replacing the VLA receivers with separate, optimized receivers. It is planned to use a VLBA front-end to test their performance for use on the VLA. Another worthwhile area of investigation would be a modification to the 18-21 cm feed to improve its spillover performance.

A VLBA front-end receiver dewar assembly has been received from the Green Bank Electronics Division. This dewar assembly along with a VLBA polarizer was installed on VLA Antenna 23. Satisfactory testing of this receiver was completed during the past year resulting in a system temperature of about 35 K. No further investigations are scheduled for this year.

High Time Resolution Processor

We have been planning for some time to instrument the VLA with a High Time Resolution Processor (HTRP). The system is planned for observations of the time varying phenomena like flare stars, pulsars, etc., and monitoring radio frequency interference (RFI). As an intermediate step a system has been designed that will utilize existing components, such as the analog sum phase array outputs of the VLA, and VLBI Mk III IDF-Video converter system, used as tunable filters with selectable bandwidths. This would provide 14 pairs of RCP and LCP frequency signals from the phased array VLA. Total power detectors and cross multipliers are used to measure all four products, with integration period of 25 micro-seconds to 5 milliseconds. Prototype of these circuits have been tested, and components for the mass production are on order. The data acquisition system is a 64 channel multiplexer and a 12 bit analog to digital converter with maximum sampling rate of 100,000 samples/sec, installed in a 386 based 20 MHz clock speed personal computer with 140 MB hard disk. The data acquisition system has been used to obtain 2-channel phased array VLA signals for developing software and understanding the system stability problems. Fabrication of the interfacing sub-system will start in the second quarter, 1989.

L. AIPS

During the quarter almost all programming effort was devoted to the "code overhaul" in which the AIPS source code is being converted from its old standards to a strict ANSI Fortran 77 standard with certain specific additions. (See Quarterly Report, April 1, 1988-June 30, 1988.) Debugging of the new code is scheduled to begin sometime in January, and the new code is expected to be released for the 15JUL89 update. There will be a 15JAN89 AIPS release which includes some minor bug fixes.

Two new members of the AIPS group have been employed to begin work early in 1989, and will be stationed at the AOC in Socorro.

M. VLA COMPUTER

Most on-line software functions required to support the Voyager encounter of Neptune have been completed. Complete testing awaits the construction of some hardware items for the analog sum ports of the correlator. The outstanding software items will be completed in January 1989. A new revision of the operating system was installed in the main computers: this incorporates the change which was necessary to eliminate the drops in the received Voyager signal.

The work on other projects has been slowed owing to the move into the new AOC building in Socorro. The Convex computer was moved and re-installed in the second week in December. The VAX 11/780 computers were moved during the following week and are expected to be operational early in the new year. In the interim, the network services to other sites are not available.

The work to replace all existing functions currently performed by the DEC-10 computer in conjunction with the Pipeline computer system is progressing well. Most of the data calibration functions have already been implemented in the AIPS software. The spectral line calibration, imaging, and display functions have been largely implemented in both AIPS and ISIS; the operations support functions have been started using VAXes and PCs; the scheduling software is being rewritten to run on PCs.

The replacement for the observation preparation program (OBSERV) is still under development. This is being done in ANSII C, and will run on Vaxes and PCs. The user interface and the help utility are complete. The utilities to specify the selection of the VLA hardware options and to support the import and export of source lists are still in progress.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

During the November 8-23, 6 and 18 cm NUG run at Pie Town, unattended antenna control and scan sequencing was performed by the VME station computer with only occasional monitoring and assistance by a remote operator in Socorro. The run achieved approximately 80 percent effective observation time. In addition, during the last quarter, an accumulated total of four days observing was performed for the NASA Crustal Dynamics Network in Mk IIIA compatibility mode at Pie Town.

The Kitt Peak telescope is scheduled to receive its final outfitting during January - February 1989. Its observational availability for Mk II Network observations is scheduled for the second quarter of 1989. Due to NRAO operation budget limitations in 1989, only Pie Town and Kitt Peak will be available for NUG observing sessions during 1989.

Telescope performance, to the extent of limited observation and test data, has been within expectations, but more rigorous testing is scheduled for the near future. Underway are more extensive pointing tests, test observations at 86 GHz, and holographic antenna surface measurement.

The first five antennas are erected. The sixth and seventh sites, Brewster, WA and Owens Valley, CA have completed antenna foundations and control buildings. Antenna erection is scheduled to begin at Owens Valley in January. A signed lease has been obtained for the Hancock, NH site. Its antenna foundation and building are expected to be under construction starting in the spring 1989. Procedures for obtaining leases for the Saint Croix, VI and Mauna Kea, HI sites continue.

Electronics

Electronics construction goals for 1988 were the completion of Racks A, B, and C with modules for initial outfitting through serial number 7, completion of front ends for 1.5 and 4.8 GHz through serial number 7, and front ends for 23 GHz through serial number 6. The racks have been completed, and the modules are about 90 percent complete.

The 1.5 and 4.8 GHz front ends have been completed, and the 23 GHz front ends through serial number 6 will be completed in the early spring. As mentioned in the report for July - September 1988, the first 23 GHz front end required further amplification to reduce the noise contribution of the first mixer. Amplifiers were procured in October and installed in the serial number 2 front end. The effect of the amplifiers was to reduce the noise temperature by 10 K near the center of the band and 20-30 K near the edges. The resulting performance is satisfactory, and we are awaiting delivery of some components that will allow completion of the remaining 23 GHz front ends planned for this year.

Masers through serial number 6 have now been received from Sigma Tau Standards Corporation. Masers 7 and 8 will be delivered early in 1989. Tests were completed on two of the masers at the JPL facility in Pasadena, and a final report on the results is expected soon.

Progress continues on the first Data Acquisition Rack to be constructed by NRAO. The wiring of the rack is now finished, and the modules are about 50 percent complete. The rack is expected to be ready for limited testing by late January 1989, although delivery of a special wirewrap board, no longer available from the original vendor, will delay completion of two of the modules until near the end of the next quarter. As the present quarter ends, documentation on construction of Data Acquisition Racks is being prepared for distribution to two companies in the private sector who plan to manufacture VLBA data-acquisition and recording equipment.

Data Recording

Preproduction Data Acquisition Rack #3 and Recorder #2 were shipped to Socorro in December. Also in December a contract change-order for initial production quantities of the VLBA Recorders was implemented with Haystack Observatory. Five production recorders and two production playback drives are to be fabricated there during 1989, plus one to be assembled at the AOC in Socorro with an eighth set of production parts, to gain in-depth recorder maintenance knowledge. The production Data Acquisition Racks to complete the VLBA antenna terminals are being assembled at NRAO Charlottesville, as are Playback Drive Interfaces to the correlator.

Work will start soon, mostly at Haystack Observatory, but also at the Array Operations Center, to perform detailed measurements of the effects of many mechanical and operational parameters on the tracking performance of the narrow track Mk IIIA and VLBA recorders. This study should provide information leading to optimizing the consistency and performance of these systems. The study is funded by NASA as well as the VLBA program.

Monitor and Control

During fourth quarter 1988 work continued on the station computer astronomical observing routines. The CHECKER routines have been brought to a useful, though far from complete, level. A first version of the data flagging routine, which tells the correlator when the data are actually good, has been written.

The second focus/rotation control equipment (for Kitt Peak) has been completed and is ready for cold-chamber tests at the VLA. A problem was found in the position encoder, which caused it to be unreliable during focus motion, due to pickup from the large motor currents. The problem is now believed fixed, although finding and fixing it took over a month.

Analysis of the pointing of the Pie Town antenna is proceeding, with emphasis on longer term variations. Short-term variations are satisfactorily small, with intra-night variations smaller than 10".

The Motorola X-25 hardware/firmware/software product has been received for communication to the central array control computer. The software component is quite different than expected, and does not include some features that would have made things much easier. The situation has become more complicated by the fact that a second alternative has become possible--changing the station computer operating system to that chosen for the correlator computers, and using the SLIP protocol--which is promised for that system--rather than the X-25 protocol. The alternative operating system--VX Works--has several other advantages over the VersaDos that is presently used, primarily in having a satisfactory C compiler. The feasibility of changing to this operating system is currently under study, as well as the design of a software system to use the Motorola X-25 device.

Correlator

Final design of the correlator "FX chip" was begun on October 31, after completion of contractual arrangements with Hall-Mark Electronics and acceptance of NRAO's purchase order. This work has progressed rapidly and satisfactorily to date, and it appears that the planned completion by the end of January 1989 can be met.

Eight bids were received for fabrication of the 112 circuit boards comprising the correlator's FFT and Cross Multiplier/Accumulator modules. Two very low bids (the lowest 43 percent below budget) offer significant savings through the bidders' highly automated processes. An order for these boards will be released upon approval of the FX chip design.

Two scientists from the Tata Institute of Fundamental Research (TIFR) in Bangalore, India, visited the correlator group for two weeks during November and December. TIFR has already decided tentatively to use the FX chip in their Giant Metrewave Radio Telescope project. The purpose of their visit was to confirm in detail the applicability of the chip, and to study possible use of the associated VLBA modules. Hall-Mark has quoted the same terms to TIFR as to NRAO for production of FX chips, and has agreed to charge both organizations based on the quantity pricing for the combined order.

All major components of the software development and correlator control environment were specified and ordered. These include a file server and five diskless workstations from Sun Microsystems, two 68030/68882-based single-board computers from Motorola, and a real-time operating system and development environment from Wind River Systems. All these procurements are scheduled for delivery early in the next quarter.

At its meeting on November 16-17 in Charlottesville, the VLBA Advisory Committee reviewed the correlator and data recording/playback subsystems in detail, emphasizing particularly the issue of compatibility with existing Mk III facilities. As a result of these and subsequent discussion, correlator specifications were extended to support a new "Mk III Hybrid Mode," which will enhance the Mk III-compatible aggregate bandwidth capability without requiring additional hardware.

Data Processing

The bulk of the software needed for the normal processing of astronomical data from the VLBA is currently available and in routine production use. There are three general areas which need to be developed: 1) the interface to the correlator and monitor data base, 2) calibration and editing of correlator output, and 3) geometric analysis of the data (i.e., astrometry and geodesy).

Software development this quarter continued the major revision of the AIPS software system. This revision consists of modifying the language of the software. The old language was Fortran 66 with some extensions; the new language will, after preprocessing, be standard Fortran 77. This revision should significantly simplify maintaining old software and developing new software.

Array Operations Center

The Array Operations Center was occupied in November by the approximately 100 combined staff members of both the VLBA and VLA. The move proceeded smoothly, with only a short disruption to most staff functions.

O. PERSONNEL

New Hires

Zensus, J. A.	Research Associate	11/01/88
Ravi, B. K.	Scientific Programming Analyst	12/01/88
Murphy, D. M.	Business Manager (Charlottesville)	12/05/88

Terminations

Palmer, P.	Visiting Scientist	10/01/88
Stobie, E.	Sr. Scientific Programming Analyst	10/28/88
Kashlinsky, A.	Visiting Research Associate	11/30/88

Transfer

P. Murphy	Scienific Programming Analyst (from Socorro to Tucson)	12/01/88

APPENDIX A

PREPRINTS RECEIVED, OCTOBER – DECEMBER, 1988

ANANTHARAMAIAH, K.R.; RADHAKRISHNAN, V.; MORRIS, D.; VIVEKNAND, M.; ET AL A Search for Radio Recombination Lines of Positronium near the Galactic Center.

ANANTHARAMAIAH, K.R.; YUSEF-ZADEH, F. A Survey of Radio Recombination Line Emission from the Galactic Center Region.

BALDWIN, J.E. The Redshift Cutoff for Steep-Spectrum Radiogalaxies.

BARTEL, N.; RUPEN, M.R.; SHAPIRO, I.I. VLBI Observations of SN1986J: Deviations from Spherical Symmetry in Its Radio Brightness Distribution.

BARVAINIS, R.; DEGUCHI, S. Single-Dish and Interferometer Measurements of Water Maser Polarization.

BIEGING, J.H.; ABBOTT, D.C.; CHURCHWELL, E.B. A Survey of Radio Emission from Galactic OB Stars.

BIRETTA, J.A.; OWEN, F.N.; CORNWELL, T.J. A Search for Motion and Flux Variations in the M87 Jet.

BREGMAN, J.N.; DAVID, L.P. Alternative Models of Cooling Flows.

BREGMAN, J.N.; HUFNAGEL, B.R. Radio and Optical Variability in Blazars.

BRIDLE, A.H.; FOMALONT, E.B.; BYRD, G.G.; VALTONEN, M.J. The Unusual Radio Galaxy 3C288.

BROWN, R.L. The Millimeter Array.

BUTNER, H.M. DCO+ in Nearby Dense Cores.

CAILLAULT, J.-P. VLA Observations of the X-ray Bright Hyades M Dwarfs.

CONDON, J.J.; BRODERICK, J.J.; SEIELSTAD, G.A. A 4.85 GHz Sky Survey. I. Maps Covering 0 deg < delta < +75 deg.

CORDOVA, F.A.; HJELLMING, R.M.; MASON, K.O.; MIDDLEDITCH, J. Soft X-ray Emission from the Radio Pulsar PSR 0656+14.

COWAN, J.J.; EKERS, R.D.; GOSS, W.M.; SRAMEK, R.A.; ET AL G.25.5+0.2: A Very Young Galactic Supernova Remnant.

CRANE, P.C. HILLENBRAND, L.A. Estimating Harmful Levels of Radio-Frequency Radiation.

ELVIS, M.; LOCKMAN, F.J.; WILKES, B.J. Accurate Galactic N sub H Values toward Quasars and AGN.

GREEN, D.A.; GULL, S.F. Observations of HI Absorption towards G74.9+1.2.

HECKMAN, T.M.; BLITZ, L.; WILSON, A.S.; ARMUS, L.; MILEY, G.K. A Mm-Wave Survey of CO Emission in Seyfert Galaxies.

HUGHES, V.A. Radio Observations of Cepheus A II. The Optical Object Cep A West (the HW Object)

HUTCHINGS, J.B.; NEFF, S.G. Tidal Interactions and Infrared-Bright QSOs.

IMPEY, C.; BOTHUN, G. Malin: A Quiescent Disk Galaxy.

IRVINE, W.M.; FRIBERG, P.; HJALMARSON, A.; ISHIKAWA, S.; ET AL Identification of the Interstellar Cyanomethyl Radical (CH2CN) in the Molecular Clouds TMC-1 and Sagittarius B2.

IRVINE, W.M.; MADDEN, S.C.; ZIURYS, L.M.; FRIBERG, P.; ET AL Observations of the CH2CN 1 01-0 00 and 4 04-3 03 Transitions.

JACKSON, P.D.; KUNDU, M.R.; WHITE, S.M. Quiescent and Flaring Radio Emission from the Flare Stars AD Leonis, EQ Pegasi, UV Ceti, Wolf 630, YY Geminorum and YZ Canis Minoris.

JAFFE, D.T.; HOWE, J.E.; GENZEL, R.; HARRIS, A.I.; ET AL Hot Quiescent Gas in Photodissociation Regions CO and C+ Observations of NGC 2023.

KRAUSE, M.; BECK, R.; HUMMEL, E. The Magnetic Field Structures in Two Nearby Spiral Galaxies II. The Bisymmetric Spiral Magnetic Field in M81.

KRAUSE, M.; HUMMEL, E.; BECK, R. The Magnetic Field Structures in Two Nearby Spiral Galaxies I. The Axisymmetric Spiral Magnetic Field in IC 342.

LEVY, G.S.; LINFIELD, R.P.; EDWARDS, C.D.; DI NARDO, S.J.; ET AL Orbiting Very Long Baseline Interferometry (OVLBI) Observations Using the Tracking and Data Relay Satellite System (TDRSS) at 2.3 and 15 GHz.

LUBOWICH, D.A.; ANANTHARAMAIAH, K.R.; PASACHOFF, J.M. A Search for Non-Cosmological Deuterium near the Galactic Center.

MANGUM, J.G.; WOOTTEN, A.; MUNDY, L.G. Synthesis Imaging of the DR21(OH) Protocluster.

MCCARTHY, P.J.; VAN BREUGEL, W.; SPINRAD, H. The Unusual Stellar Object Associated with the Radio Source 3C 435B.

MEISENHEIMER, K.; ROSER, H.-J.; HILTNER, P.R.; YATES, M.G.; ET AL The Synchrotron Spectra of Radio Hot Spots.

MIGENES, V.; JOHNSTON, K.J.; PAULS, T.A.; WILSON, T.L. The Distribution and Kinematics of Ammonia in the Orion-KL Nebula: High Sensitivity VLA Maps of the NH3(3,2) Line.

NASH, A.G. The Abundance Ratio of Formaldehyde to Ammonia in Molecular Clouds Observed toward Radio Continuum Sources.

O'DEA, C.P. Constraints on Integrated Nuclear Rotation Measures in Core-Dominated Active Galactic Nuclei.

OWEN, F.N.; HARDEE, P.E.; CORNWELL, T.J. High Resolution, High Dynamic Range VLA Images of the M87 Jet at 2cm.

OWEN, F.N.; HARDEE, P.E.; CORNWELL, T.J.; HINES, D.C.; EILEK, J.A. New VLA Results on M87.

PEDELTY, J.A.; RUDNICK, L.; MCCARTHY, P.J.; SPINRAD, H. The Clumpy Medium around Distant Radio Galaxies.

PEDLAR, A.; ANANTHARAMAIAH, K.R.; EKERS, R.D.; GOSS, W.M.; ET AL Radio Studies of the Galactic Center. I. The Sagittarius A Complex.

POMPEA, S.M.; REIKE, G.H. Inhibition of Star Formation in SA Galaxies.

SASLAW, W.C. Some Properties of a Statistical Distribution Function for Galaxy Clustering.

SNYDER, L.E.; PALMER, P.; DE PATER, I. Radio Detection of Formaldehyde Emission from Comet Halley.

THOMPSON, A.R. Coordination between the Radio Astronomy Service and the Radiodetermination Satellite Service in the 1612 MHz Band.

TURNER, B.E.; RICKARD, L.J; XU, L.-P. Cirrus Cloud Cores: A Deficient Chemistry?

VAN GORKOM, J.H.; KNAPP, G.R.; EKERS, R.D.; EKERS, D.D.; ET AL HI Absorption in Radio Elliptical Galaxies – Evidence for Infall.

VANDER VEEN, W.E.C.J.; GEBALLE, T.R.; HABING, H.J.; VAN LANGEVELDE, H.J. IRAS 17516-2525: An Evolved Star or a Young Stellar Object?

VENTURI, T.; FERETTI, L.; GIOVANNINI, G. Evidence of Gas around Two Radio Galaxies at the Coma Cluster Periphery.

WOOTTEN, A.; BOULANGER, F.; ZHOU, S.; COMBES, F.; ET AL H3O+ Revisited.

WOOTTEN, A.; LOREN, R.B. Sulfur Oxides in the rho Ophiuchi Cloud Cores: Symptoms of Star Foramtion?

ZUCKERMAN, B.; DYCK, H.M. Outflow Velocities from Carbon Stars.