NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

October 1, 1985 - December 31, 1985

TABLE OF CONTENTS

A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1898.75	1819.00	1871.00	1592.30
Scheduled maintenance and equipment changes	136.00	105.75	91.50	212.00
Scheduled tests and calibrations	116.25	0.00	173.25	349.20
Time lost	180.50	101.50	258.25	
Actual Observing	1834.50	1717.50	1612.75	1492.00

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
M-250	Maddalena, R.	Observations at 1.5 cm for star formation associated with very young molecular clouds.
S-283	Seielstad, G. Lehto, H. (Virginia)	Observations at 1.5 cm of periodic variations in OJ 287 and other extragalactic radio sources.
U-22	Uson, J.	Continue search at 19.5 GHz for small-scale anisotropy of the microwave background.
U-23	Uson, J.	Observations of the Sunyaev-Zeldovich effect at 19.5 GHz.

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
B-422	Bell, M. (Herzberg Inst.) Matthews, H. (Herzberg Inst.) Sears, T. (Brookhaven)	Observations at discrete frequencies between 9.3 and 10.1 GHz and between 18.6 and 20.3 GHz to search for C_5H in TMC1 and to examine IRC+10°216 for HC_9N and C_5H.

No.	Observer(s)	Programs
B-424	Batrla, W. (Illinois)	Observations at 6 cm of Comet Hartley-Good in a target of chance mode.
B-445	Batrla, W. (Illinois)	Search over the range of 12-16 GHz and 18-25 GHz for molecular line transitions from Halley's Comet.
C-234	Claussen, M. (Massachusetts) Jordan, C. (Massachusetts) Kleinmann, S. (MIT) Schloerb, F. (Massachusetts)	Observations at 18 cm to search for OH emission from comets Giacobini-Zinner and Hartley-Good, and from stars having latitudes $>10°$ selected from the IRAS Catalog.
L-159	Lockman, F. J.	A deep systematic 5-cm recombination line survey of continuum sources in the galaxy.
M-241	Madden, S. (Massachusetts) Brown, R. D. (Monash) Godfrey, P. (Monash) Irvine, W. (Massachusetts) Matthews, H. (Herzberg Inst.)	Observations at discrete wavelengths over the range of 4-5.3 cm to study non-metastable NH_3 inverson transitions in star-forming regions.
M-242	Matthews, H. (Herzberg Inst.) Avery, L. (Herzberg Inst.) Irvine, W. (Massachusetts) Thaddeus, P. (Inst. for Space Studies)	Observations at 12.0, 12.8, 18.2, 18.3 and 21.6 GHz of the abundant ring molecule C_3H_2.
M-249	Maddalena, R. Morris, M. (Calif., Los Angeles) Yusef-Zadeh, F. (Columbia)	Observations at discrete frequencies over the range of 23.6-24.2 GHz for NH_3 emission from the arched continuum filaments of the galactic center.
S-289	Schloerb, F. (Massachusetts) Claussen, M. (Massachusetts)	Observations of the 18-cm OH transitions in Halley's Comet.
S-294	Seaquist, E. (Toronto) Bell, M. (Herzberg Inst.)	Search at 18.343 GHz for C_3H_2 (cyclopropenylidene) in external galaxies.
T-192	Turner, B. Ziurys, L. (Massachusetts)	Studies at 9 cm of the excitation of interstellar ^{12}CH.
T-199	Turner, B. Ziurys, L. (Massachusetts)	Observations at 9 cm for CH in Halley's Comet.
W-199	Wolfe, A. (Pittsburgh) Briggs, F. (Pittsburgh)	Search for redshifted 21-cm absorption in QSO OC 383 and 2136+14.

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

A - Arecibo 1000 ft	Lb - Bologna 25 m
B - Effelsberg, MPIR 1000 m	Lm - Medicina 32 m
Dm - Goldstone 210 ft	N - NRL Maryland PT 85 ft
F - Fort Davis 85 ft	O - Owens Valley 130 ft
G - Green Bank 140 ft	R - Crimea USSR 30 m
H - Hat Creek 85 ft	Sn - Onsala 20 m
I - Iowa 60 ft	So - Onsala 25 m
Jb - Jodrell Bank MK II 25 m	Wn - Westerbork n=1-14x26 m
Jm - Jodrell Bank 250 ft	Yn - Socorro n=1-27x25 m
Km - Haystack 120 ft	

No.	Observer(s)	Program
B-65V	Bartel, N. (CFA)	Observations at 6 cm of SN 1979c with telescopes B, G, O, and Yn.
B-67V	Backer, D. (Calif., Berkeley) Plambeck, R. (Calif., Berkeley) Readhead, A. (Caltech) van Breugel, W. (Calif., Berkeley) Wright, M. (Calif., Berkeley)	Observations at 1.3 cm of the structure of compact components in NGC 1275 with telescopes B, G, Km, N, O, Sn, and Yn.
B-439V	Briggs, F. (Pittsburgh) Wolfe, A. (Pittsburgh)	Observations at 467 MHz of redshifted HI in QSO PKS 0458-02 with telescopes A and G.
D-9V	Diamond, P. (MPIR, Bonn) Chapman, J. (Manchester) Johnston, K. (NRL) Matveyenko, L. (IFSR, USSR)	Monitor at 1.3 cm the H_2O masers around the supergiant S Per with telescopes B, G, Km, N, O, Sn, and Yn.
G-46V	Graham, D. (MPIR, Bonn) Diamond, P. (MPIR, Bonn) Matveyenko, L. (IFSR, USSR)	Observations at 1.35 cm of the Orion H_2O maser with telescopes B, G, Km, Lm, O, R, Sn, and Yn.
H-17V	Hooimeyer, J. (Leiden) Miley, G. (STScI) Schilizzi, R. (NFRA) van der Hulst, J. (NFRA)	Observations at 6 cm to study compact structure in LINER galaxies with telescopes B, G, Jb, Lm, O, So, Wn, and Yn.
M-63V	Mutel, R. (Iowa) Phillips, R. (Haystack)	Monitoring at 2.8 cm of superluminal motion in BL Lac with telescopes F, G, H, Km, Lm, O, and Yn.
M-66V	Marcaide, J. (MPIR, Bonn) Eckart, A. (MPIR, Bonn)	Observations at 6 cm of 1928+738 phase-referenced to 2007+777 with telescopes B, F, G, Km, Lm, O, So, and Yn.

No.	Observer(s)	Program
M-70V	Mutel, R. (Iowa) Spangler, S. (Iowa)	Observations at 6 cm of angular broadening in the vicinity of the Cygnus Superbubble with telescopes B, F, G, H, I, Jb, Km, O, and Yn.
M-71V	Molnar, L. (CFA) Grindlay, J. (CFA) Preston, R. (CFA) Reid, M. (CFA)	Observations at 1.3 cm of Cygnus X-3 to model its expansion with telescopes B, Dm, G, Km, Lb, O, Sn, and Yn.
M-74V	Marscher, A. (Boston U.) Shaffer, D. (Interferometrics)	Monitoring at 2.8 cm of superluminal motion amid the stationary structure of 4C 39.25 with telescopes F, G, H, Km, Lm, and O.
P-58V	Pearson, T. (Caltech) Readhead, A. (Caltech)	Second-epoch observations at 6 cm of a complete sample of 20 sources with telescopes B, F, G, H, I, Km, O, and Yn.
P-63V	Preuss, E. (MPIR, Bonn) Alef, W. (MPIR, Bonn)	Observations at 6 cm of 3C 272.1 with telescopes B, G, Lb, O, So, Wn, and Yn.
P-66V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. (Caltech) Kellermann, K.	Monitoring at 2.8 cm of 3C 454.3 with telescopes F, G, H, Km, Lm, and O.
P-70V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. (Caltech) Kellermann, K.	Observations at 1.3 cm of 3C 454.3 with telescopes B, G, Km, O, Sn, and Yn.
P-71V	Bartel, N. (CFA) Gregorini, L. (Bologna) Fanti, R. (Bologna) Ficarra, A. (Bologna) Mantovani, F. (Bologna) Nicolson, G. (Hartebeesthoek) Padrielli, L. (Bologna) Weiler, K. (NSF) Romney, J.	Observations at 6 cm of sources showing structural changes at 18 cm with telescopes B, F, G, H, Jm, Km, Lm, O, So, and Wn.
S-50V	Simon, R. (NRL) Cawthorne, T. (Cambridge) Hough, D. (Caltech) Scheuer, P. (Cambridge)	Observations at 6 cm to map 3C 454 and 3C 43 with telescopes A, B, F, G, Km, N, O, and Yn.

No.	Observer(s)	Programs
S-52V	Schilizzi, R. (NFRA) Barthel, P. (Caltech) Miley, G. (STScI) Hooimeyer, J. (Leiden)	Observations at 6 cm of compact cores in extended quasars with telescopes B, G, Jb, Lm, O, So, Wn, and Yn.
U-15V	Unwin, S. (Caltech) Baath, L. (Onsala) Biretta, J. (Caltech) Cohen, M. (Caltech) Readhead, A. (Caltech) Zensus, A. (Caltech)	Observations at 1.3 cm of 3C 279 with telescopes B, G, Jb, Km, N, O, and Yn.
W-23V	Walker, R. C. Unwin, S. (Caltech) Benson, J. Seielstad, G.	Observations at 6 cm of 3C 120 with telescopes B, F, G, H, I, Km, O, and Yn.
W-38V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL) Schalinski, C. (MPIR, Bonn) Simon, R. (NRL)	Observations at 6 cm of a complete sample of extragalactic radio sources with telescopes B, G, Jb, Km, Lm, O, So, Wn, and Yn.
W-39V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Schalinski, C. (MPIR, Bonn) Simon, R. (NRL)	Observations at 1.3 cm of the submilli-arcsecond structure of a complete sample of extragalactic radio sources with telescopes B, G, Km, Lm, O, Sn, and Yn.
X-36V	Spencer, J. (NRL)	Observations at 1.3 cm and 6 cm of Cyg X-3 with telescopes G and N.
X-37V	Bartel, N. (CFA) Ho, P. (CFA) Turner, J. (CFA)	Observations at 6 cm of the jet like extensions of NGC 253 with telescopes F, G, O, and Yn.
X-38V	Mantovani, F. (Bologna)	Observations at 2.8 cm of 0224+671 and 1055+018 with telescopes F, G, H, Km, Lm, and O.
Z-10V	Zensus, A. (Caltech) Baath, L. (Onsala) Cohen, M. (Caltech) Lind, K. (Caltech) Unwin, S. (Caltech)	High-dynamic range observations at 6 cm of 3C 273 and 3C 345 with telescopes B, F, G, H, I, Km, Lm, O, So, Wn, and Yn.

No.	Observer(s)	Programs
Z-11V	Zensus, A. (Caltech) Biretta, J. (Caltech) Cohen, M. (Caltech) Unwin, S. (Caltech) Wrobel, J. (Caltech)	Observations at 2.8 cm of the kinematics and polarization of 3C 345 with telescopes F, G, H, Km, Lm, and O.

C. 300-FT OBSERVING PROGRAMS

The following continuum program were conducted during this quarter.

No.	Observer(s)	Programs
A-59	Aller, H. (Michigan) Aller, M. (Michigan) Fanti, R. (Bologna) Ficarra, A. (Bologna) Mantovani, F. (Bologna) Padrielli, L. (Bologna)	Observations at 1400 and 2695 MHz of low frequency variable sources selected from the Bologna-Michigan Program.
B412	Burke, B. (MIT) Carilli, C. (MIT) Langston, G. (MIT)	Observations at 6 cm to continue the MIT-Green Bank survey at $\delta = 20^\circ < < 45^\circ$.
E-43	Erickson, W. (Maryland) Ananthakrishnan, S. (Tata) Bagri, D. (Tata) Cane, H. (Maryland)	Observations over the range of 100-300 MHz to study the polarization and flux of low-frequency variable sources.
O-32	O'Dea, C. Balonek, T. (Colgate) Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)	Polarization and flux-density measurements of variable sources at 2695 MHz.
S-292	Simonetti, J. Cordes, J. (Cornell)	Observations at 700 and 1410 MHz of the flicker of extragalactic radio sources.
S-299	Simonetti, J. Cordes, J. (Cornell)	Observations at 820 and 1410 MHz of the flicker of extragalactic radio sources.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
G-286	Gottesman, S. (Florida) Erickson, L. (Florida) Hunter, J. (Florida)	Observations of HI in NGC 4111 and NGC 5689.
T-195	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations at 21 cm to obtain precision redshifts and profile widths.

No.	Observer(s)	Program
T-198	Thuan, T. (Virginia) Schneider, S. (Virginia)	Survey of dwarf galaxies in the Nilson Catlalog for neutral hydrogen and to determine redshifts.
U-21	Uson, J. Fisher, J. R.	Search over the range of 280-350 MHz for redshifted hydrogen from Zeldovich pancake objects.
W-203	Wootten, H. A. Hartman, L. (Leiden) Armstrong, J. T.	Observations of extragalactic HI in infrared-bright galaxies.

The following pulsar program was conducted during the quarter.

No.	Observer(s)	Program
D-139	Dewey, R. (Cornell) Stokes, G. (Princeton) Taylor, J. (Princeton) Weisberg, J. (Princeton)	Monitoring at 390 MHz of the Princeton-NRAO pulsar timing observations.

D. 12-METER OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A79	Avery, L. (Herzberg Inst.) Broton, N. (Herzberg Inst.) MacLeod, J. (Herzberg Inst.) Amano, T. (Herzberg Inst.)	A search for C_2D--a potential diagnostic of molecular cloud age.
B411	Barrett, A. (MIT) Jackson, J. (MIT) Ho, P. (CFA)	CO survey of star-burst galaxies.
D146	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of evolution of extragalactic radio sources at millimeter wavelengths.
E47	Sanders, D. (Caltech) Elias, J. (Caltech)	Study of CO observations of local group dwarf irregular galaxies.
F86	Feldman, P. (Algonquin) Matthews, H. (Algonquin) Saito, S. (Kyoto, Japan)	A search for interstellar HPO.
G284	Gordon, M. Gallagher, J. (KPNO) Hunter, D. (DTM)	Study of CO emission in M33; vicinity of water masers.

No.	Observer(s)	Program
G285	Gordon, M. Gallagher, J. (KPNO) Hunter, D. (DTM)	Study of CO emission in M33; dense clouds.
H204	Heckman, T. (Maryland) Blitz, L. (Maryland) Wilson, A. (Maryland) Miley, G. (Johns Hopkins)	A survey of CO emission in bright, nearby Seyfert Galaxies.
H210	Huggins, P. (New York) Healy, A. (New York)	Study of CO in planetary nebulae.
H211	Huggins, P. (New York) Healy, A. (New York) Thaddeus, P. (Inst. for Space Studies) Gottlieb, C. (Inst. for Space Studies)	Study of high-frequency lines of SiC_2, C_3H, and C_3H_2.
H213	Hoban-Magnani, S. (Maryland) Baum, S. (Maryland)	A search for CO^+ in Comet P/Halley.
J110	Jewell, P. Schenewerk, M. (Illinois) Snyder, L. (Illinois)	A search for HCN in oxygen-rich circumstellar envelopes.
J112	Jannuzi, B. (Arizona) Lada, C. (Arizona) Black, J. (Arizona) van Dishoeck, E. (CFA)	Detailed studies of CO emission from diffuse clouds.
J113	Jaffe, W. (Johns Hopkins) Gavazzi, G. (Milano)	Study of recent star formation in Coma/A1367 supercluster.
J114	Jaffe, W. (Johns Hopkins)	Search for CO emission in M37 and NGC 1275.
L197	Lada, C. (Arizona)	Study of spatially resolved CO maps of bipolar flow around Mon R2.
L198	Liszt, H.	Study of CO J=1-0 mapping of Seyfert galaxies.
M237	Margulis, M. (Arizona) Lada, C. (Arizona)	Study of CO emission from molecular outflows in NGC 2264.
M238	McCutcheon, W. (Br. Columbia) Nordal, R. (Br. Columbia)	Study of CO observations of S211/212.

No.	Observer(s)	Program
M243	Martin, H. Mundy, L. (Caltech)	Study of bumpy lines from clumpy clouds.
M246	Mebold, U. (Arizona) Martin, R. (Arizona)	Study of CO-lines between Draco Nebula and high-velocity clouds.
P132	Payne, J. Reynolds, S. Rhodes, P. Salter, C. (IRAM)	Observations of crab-like supernova remnants at 90 GHz.
R222	Rickard, L. J (NRL) Blitz, L. (Maryland)	Studies of apparent variations in $^{12}CO/^{13}CO$ in galaxies.
S278	Sanders, D. (Caltech) Scoville, N. (Caltech) Soifer, B. (Caltech)	Study of CO observations of bright IRAS Galaxies.
S284	Smith, H. (NRL) Fischer, J. (NRL) Thronson, H. (Wyoming)	Study of broad-wing CO emission from low-luminosity stars.
S287	Schenewerk, M. (Illinois) Snyder, L. (Illinois) Hollis, J. M. (Goddard)	A survey of the 1-0 transition of HCO.
S291	Salter, C. Jewell, P. Shaver, P. (ESO) Patnaik, A. (Tata, India) Hunt, G. (Johns Hopkins)	Mapping of the CO distribution over the peculiar SNR G357.7-0.1.
T196	Thronson, H. (Wyoming)	Study of the molecular component of blue dwarf galaxies.
T201	Thronson, H. (Wyoming)	High-resolution observations of CO emission from NGC 7027.
T202	Turner, B. Ziurys, L. (Massachusetts)	Study of interstellar $HCNH^+$.
V53	Verter, F. (Rensselaer) Rickard, L. J (NRL) Kutner, M. (Rensselaer) Turner, B.	Continuation of CO (2-1) map of M31; nature of clouds in beam.
V54	Verter, F. (Rensselaer) Kutner, M. (Rensselaer)	Completion of study of arm-interarm contrast in M51.

No.	Observer(s)	Program
W197	Walker, C. (Arizona) Kailey, W. (Arizona) Lada, C. (Arizona)	Study of CO emission from IRAS galaxies.
W198	Walker, C. (Arizona) Lada, C. (Arizona)	Proposal to study molecular outflows toward AFGL2591 and RCrA.
W202	Webster, A. (Royal Obs.) Nicholls, A. (Edinburgh)	CO observations of lunar occultations of molecular clouds.
Z51	Zuckerman, B. (UCLA)	Search for HCN in selected carbon stars.

E. VLA OBSERVING PROGRAMS

No.	Observer(s)	Program
AA-45	Antonucci, R. Perley, R. Ritter, B. (NMIMT)	3C 273. 20 cm.
AA-49	Armstrong, J. T. Ho, P. (CFA)	$NH_3(1,1)$ emission within 3 parsec of the Galactic Center. 1.3-cm line.
AB-318	Brown, A. (Colorado) Drake, S. (Colorado) Walter, F. (Colorado)	Southern PMS stars. 6 cm.
AB-324	Blaha, C. (Minnesota) Pedelty, J. (Minnesota) Dickey, J. (Minnesota) Kennicutt, R. (Minnesota)	"Hot spot" nuclei. 6 cm.
AB-325	Bieging, J. (Calif., Berkeley) Cohen, M. (NASA-Ames)	Flux density and spectral index monitoring of V410 Tau. 2 and 6 cm.
AB-333	Becker, R. (Calif., Davis) Helfand, D. (Columbia)	Galactic supernova remnants. 6 cm.
AB-336	Bieging, J. (Calif., Berkeley) Goss, W. M. (Groningen)	HI absorption in Cas A. 21-cm line.
AB-339	Becker, R. (Calif., Davis) Helfand, D. (Columbia)	G5.3-1.0 and G357.7-0.1. 6 and 20 cm.

No.	Observer(s)	Program
AB-342	Burstein, D. (Arizona State) Yin, Q. (Beijing U.) Condon, J.	The relationship of stellar populations to radio continuum emission in normal spiral galaxies. 20 cm.
AB-344	Briggs, F. (Pittsburgh)	Extensive HI disks around galaxies. 21-cm line.
AB-346	Bridle, A. Perley, R.	Low-brightness features of NGC 6251. 6 and 20 cm.
AB-351	Birkinshaw, M. (Harvard Obs.) Moffet, A. (Caltech)	A search for weak radio sources contaminating measurements of the Sunyaev-Zeldovich effect. 2, 6 and 20 cm.
AB-352	Baum, S. (Maryland) Bridle, A. Heckman, T. (Maryland) Miley, G. (STScI) van Breugel, W. (Calif., Berkeley)	1717-00 = 3C 353. 1.3 and 2 cm.
AB-353	Bhattacharya, D. (Raman Inst.) Srinivasan, G. (Raman Inst.) van Gorkom, J. (Princeton)	H110α-recombination line toward compact sources in the Galactic Plane. 6-cm line.
AB-355	Bridle, A. Perley, R.	Low-resolution mapping of three very large B3 sources. 6 and 20 cm.
AB-357	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring the radio star HD193793. 6 cm.
AB-358	Becker, R. (Calif., Davis) Helfand, D. (Columbia)	Neutral-hydrogen absorption measurements to SNR. 21-cm line.
AB-361	Brown, R. Gordon, M.	CII region in the Rho Ophiuchius dark cloud. 6-cm line.
AB-363	Bookbinder, J. (Harvard) Lamb, D. (CFA)	Further search for radio emission from magnetic cataclysmic variables. 2, 6 and 20 cm.
AB-364	Bookbinder, J. (Harvard) Lamb, D. (CFA)	Search for radio emission from the AM Her Star 4U0541+60. 1.3, 2 and 6 cm.
AB-365	Briggs, F. (Pittsburgh)	NGC 3344: a galaxy with extended HI emission and anomalous metal abundances. 20-cm line.

No.	Observer(s)	Program
AB-366	Barvainis, R. Wootten, H. A.	Linear polarization of ammonia and magnetic field mapping. 1.3 cm.
AC-101	Condon, J.	Continuum survey of bright spiral galaxies. 20 cm.
AC-118	Clark, F. Bridle, A. van Gorkom, J. (Princeton)	OH emission/absorption in bipolar flows associated with young stars. 18-cm line.
AC-137	Carignan, C. (Montreal) Freeman, K. (ANU)	Mass distribution in the dwarf irregular DDO 154. 21-cm line.
AC-142	Coles, W. (San Diego) Rickett, B. (San Diego) Armstrong, J. (JPL) Kojima, M. (Nagoya)	Solar wind observations very near the Sun. 1.3, 2 and 6 cm.
AC-143	Chanmugam, G. (Louisiana State) Dulk, G. (Colorado) Bastian, T. (Colorado)	Radio emission from magnetized cataclysmic variable stars. 2, 6 and 20 cm.
AC-144	Comins, N. (Maine)	Large-scale structures in 3C 442. 6 and 20 cm.
AC-145	Carignan, C. (Montreal)	HI observations of NGC 7793. 21-cm line.
AD-145	Duric, N. (British Columbia) Seaquist, E. (Toronto) Crane, P. Davis, L. (NOAO)	Spiral galaxy NGC 4736. 2 and 6 cm
AD-167	de Pater, I. (Calif., Berkeley) Ip, W. (MPI Lindau) Snyder, L. (Illinois) Palmer, P. (Chicago) Bolton, S. (Calif., Berkeley)	OH emission by Halley's comet. 18 and 21-cm line.
AD-173	Dickey, J. (Minnesota) Salpeter, E. (Cornell)	HI in galaxies in the cluster A400. 21-cm line.
AD-174	Dressel, L. (Rice)	Neutral hydrogen in a normal giant elliptical galaxy: NGC 807. 21-cm line.
AD-175	Dreher, J. (MIT) Welch, W. J. (Calif., Berkeley)	W43, W49A, W51. 6 cm.

No.	Observer(s)	Programs
AE-42	Ekers, R. Fanti, R. (Bologna) Fanti, C. (Bologna) Parma, P. (Bologna)	B2 1637+28. 6 cm.
AF-107	Furst, E. (MPI, Bonn) Reich, W. (MPI, Bonn) Hummel, E. (MPI, Bonn)	G18.95-1.1, an extended galactic source with a possible binary system. 6 and 20 cm.
AF-108	Fomalont, E. Ekers, R. van Breugel, W. (Calif., Berkeley)	Fornax A. 6 and 20 cm.
AG-116	Gibson, D. (NMIMT) Priedhorsky, W. (LANL)	A search for 300-day periodicity in Cyg X-1. 2, 6 and 20 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Queen Mary College) Ade, P. (Queen Mary College) Robson, E. (UKIRT) Nolt, I. (Oregon) Smith, M. (ROE)	Monitoring blazars. 1.3, 2, 6, 20 and 90 cm.
AG-191	Gavazzi, G. (FC Milan) Jaffe, W. (STScI)	Coma/A1367 supercluster survey. 20 cm.
AG-192	Gathier, R. (ESO) Garay, G. (ESO)	Kinematics of the planetary nebulae NGC 6543 and NGC 7009. 2-cm line.
AG-194	Giovannini, G. (Bologna) Feretti, L. (Bologna) Andernach, H. (MPI, Bonn)	Extended source near Coma A. 6 cm.
AG-198	Gee, G. (Queen Mary) Schwartz, P. (NRL)	IRAS selected CO broad-winged sources. 6 and 20 cm.
AG-199	Gottesman, S. (Florida) Hunter, J. (Florida) Erickson. L. (Florida)	HI observations of NGC 4258 and NGC 4303. 21-cm line.
AG-200	Giovannini, G. (Bologna) Feretti, L. (Bologna)	NGC 4869. 2, 6 and 20 cm.
AG-201	Geldzahler, B. (NRL)	Snapshot observations of M32. 6 cm.
AG-205	Garay, G. (ESO) Andersson, M. (Onsala)	Ammonia observations of the hot molecular gas associated with the ultracompact HII region G34.3+0.2. 1.3-cm line.

No.	Observer(s)	Program
AH-191	Ho, P. (CFA) Lo, K. (Caltech)	Linear continuum structures in the Galactic plane. 6 cm.
AH-195	Hjellming, R. Davis, R. (Jodrell Bank)	Recurrent nova RS Oph. 1.3, 2, 6 and 20 cm.
AH-206	Helfand, D. (Columbia) Becker, R. (Calif., Davis) Zoonermatkermani, S. (Columbia)	Field surrounding G12.0-0.1: a cluster of supernova remnants? 6 cm.
AH-208	Hoban-Magnani, S. (Maryland) Baum, S. (Maryland)	Icy grain halo of comet P/Halley. 2 cm.
AH-209	Helou, G. (JPL) Kotanyi, C. (ESO)	Normal galaxies. 20 cm.
AH-211	Ho, P. (CFA) Turner, J. (CFA)	HI synthesis mapping of NGC 253. 21-cm line.
AH-212	Haynes, M. (Cornell/NAIC) Giovanelli, R. (NAIC)	HI near extragalactic HII regions. 21-cm line.
AH-213	Hills, R. (Cambridge) Russell, A. (Cambridge)	Search for high-velocity HI in molecular outflow sources. 21-cm line.
AI-20	Inoue, M. (Nobeyama) Tabara, H. (Utsunomiya) Kato, T. (Utsunomiya) Tsuboi, M. (Tokyo) Fomalont, E.	Magnetic field on the radio arc at the Galactic Center. 2 and 6 cm.
AJ-118	Johnston, K. (NRL) Spencer, J. (NRL) Hjellming, R. Angerhoffer, P. (USNO) Florkowski, D. (USNO) Reid, M. (CFA)	Structure of Cyg X-3 in outburst. 1.3, 2, 6 and 20 cm.
AJ-127	Johnston, K. (NRL) Wilson, T. (MPI, Bonn) Simon, R. (NRL) Spencer, J. (NRL)	The Orion nebula. 6 cm.
AK-110	Kim, K. (Toronto) Kronberg, P. (Toronto) Dewdney, P. (DRAO) Landecker, T. (DRAO)	Polarization observation of radio halos in Abell clusters. 20 cm.

No.	Observer(s)	Program
AK-128	Kwok, S. (Calgary) Arquilla, R. (Calgary) Ying, F. (Beijing)	NH_3 observations of the circumstellar envelope of IRC+10216. 1.3-cm line.
AK-129	Kronberg, P. (Toronto)	M82. 1.3 cm.
AK-131	Kundu, M. (Maryland) Jackson, P. (Maryland) Pallavicini, R. (Arcetri)	Simultaneous VLA and EXOSAT observations of selected flare stars: YZ CMi. 6 and 20 cm.
AK-133	Keto, E. (Harvard) Ho, P. (CFA) Haschick, A. (Haystack)	Spin-up and accretion in molecular cloud cores around OB clusters. 1.3-cm line.
AK-134	Kundu, M. (Maryland) Schmahl, E. (Maryland) Szabo, A. (Maryland)	Simultaneous VLA microwave and Clark Lake meter-decameter solar burst observations. 6, 20 and 90 cm.
AK-135	Killeen, N. Bicknell, G. (Mt. Stromlo) Ekers, R.	NGC 612 (PKS 0131-36). 2, 6 and 20 cm.
AK-136	Killeen, N. Bicknell, G. (Mt. Stromlo) Ekers, R.	IC 4296 (PKS 1333-33). 2, 6 and 20 cm.
AK-137	Kutner, M. (Rensselaer) Evans, N. (Texas) Mundy, L. (Caltech)	H_2CO emission as a probe of high-density clumping in molecular clouds. 6-cm line.
AK-138	Keto, E. (Harvard) Ho, P. (CFA) Haschick, A. (Haystack)	Accreting molecular cloud core around the OB cluster G10.6-0.4. 1.3-cm line.
AK-139	Kapahi, V. (Tata Inst.) Kulkarni, V. (Tata Inst.)	Epoch dependence of the sizes and spectra of radio galaxies. 6 cm.
AL-100	Liszt, H.	Survey of recombination-line emission from Galactic Center continuum sources outside Sgr A. 6-cm line.
AL-101	Lang, K. (Tufts) Willson, R. (Tufts) Pallavicini, R. (Arcetri)	Simultaneous VLA, EXOSAT and IUE observations of the RS CVn star λAND. 2, 6 and 20 cm.
AL-102	Lasenby, A. (Cambridge) Lewtas, J. (Cambridge) Yusef-Zadeh, F. (Columbia)	HI absorption study of the radio arc region of the Galactic Center. 21-cm line.

No.	Observer(s)	Program
AL-106	Leahy, J. (Manchester) Morison, I. (Manchester) Muxlow, T. (Manchester) Stephens, P. (Manchester)	Spectral mapping over 2 decades of frequency. 2 cm.
AM-124	McHardy, I. (Leicester) Warwick, R. (Leicester) Smith, A. (ESTEC)	Coordinated radio, optical and X-ray observations of OVVs and BL Lacertae objects. 2, 6 and 20 cm.
AM-157	Mirabel, I. (Puerto Rico) Rodriguez, L. (UNAM) Canto, J. (UNAM) Ruiz, A. (Puerto Rico)	High-velocity OH in absorption toward selected sources. 18-cm line.
AM-158	Massi, M. (Arcetri) Felli, M. (Arcetri) Tofani, G. (Arcetri) Falchi, A. (Arcetri)	Kinematics of the blister-type HII region Mon R2. 6-cm line.
AM-159	Mebold, U. (Bonn U.) Kalberla, P. (MPI, Bonn)	High-velocity clouds and their interaction with the Draco nebula. 21-cm line.
AM-160	MacLeod, J. (Herzberg) Vallee, J. (Herzberg) Broten, N. (Herzberg)	Faraday rotation through and near the Eridanus Cavity. 6, 18 and 20 cm.
AM-161	Magri, C. (Cornell) Haynes, M. (Cornell)	Neutral hydrogen as a tracer of interaction in the NGC 3169 group. 21-cm line.
AM-164	Mundy, L. (Caltech) Masson, C. (Caltech)	Search for dust continuum emission in Orion. 1.3 and 2 cm.
AO-61	Oznovich, I. (NMIMT) Gibson, D. (NMIMT)	Magnetic activity in five late-type giants and supergiants. 6 cm.
AO-62	O'Donoghue, A. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Wide-angle tail sources. 6 cm.
AO-63	O'Dea, C. Owen, F.	The tail of NGC 1265. 20 cm.
AP-104	Pedlar, A. (Jodrell Bank) Unger S. (Jodrell Bank) Axon, D. (Jodrell Bank)	HI studies of pairs of galaxies with active nuclei: NGC 4151/4145. 21-cm line.

No.	Observer(s)	Program
AP-105	Perley, R. Crane, P.	Accurate flux-density measurements of Baars calibrators. 1.3, 2, 6 and 20 cm.
AR-129	Rodriguez, L. (UNAM) Garcia-Barreto, J. (UNAM) Gomez, Y. (UNAM)	Twice ionized helium in NGC 6302. 2-cm line.
AR-131	Rodriguez, L. (UNAM) Torrelles, J. (UNAM) Canto, J. (UNAM) Curiel, S. (UNAM) Ho, P. (CFA) Pravdo, S. (JPL)	Herbig-Haro 1 and 2 region. 2 and 6 cm.
AR-132	Reich, W. (MPI, Bonn) Furst, E. (MPI, Bonn)	A complex structure in the center of G179.0+2.7. 6 and 20 cm.
AR-133	Retallack, D.	HII region M 16. 2, 6 and 20 cm.
AR-134	Rickard, L. J (Sachs-Freeman/NRL) Turner, B.	Position of the 1667-MHz "megamaser" in M31. 18-cm line.
AR-135	Rickard, L. J (Sachs-Freeman/NRL) Turner, B.	The 1667-MHz "megamaser" in UGC 8696. 18-cm line.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NSF)	Supernovae SN 1980 in NGC 6946 and SN 1979c in M100. 6 and 20 cm.
AS-211	Sramek, R. Weiler, K. (NSF) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-220	Slee, O. (CSIRO) Perley, R.	Two complete samples of steep spectrum sources. 6 cm.
AS-224	Smith, A. (ESTEC) Peacock, A. (ESTEC)	SNR W49B. 6 cm.
AS-231	Sievers, A. (MPI, Bonn) Wielebinski, R. (MPI, Bonn)	Spectrum and morphology of radio halos in Abell clusters A1367, A1656, A2319. 20 cm.
AS-233	Simon, M. (SUNY, Stony Brook) Vader, P. (Yale)	HI observations of selected IRAS galaxies. 21-cm line.
AS-243	Simon, R. (NRL) Spencer, J. (NRL)	Radio emission from $\alpha 2$ CVn stars. 6 cm.

	Johnston, K. (NRL)	
AS-245	Singal, A. (TIFR)	Giant radio galaxy 1331-09. 2, 6 and 20 cm.
AT-60	Taylor, A. (Groningen) Seaquist, E. (Toronto) Kenyon, S. (CFA)	Radio-optical-UV monitoring of symbiotic stars. 1.3, 2, 6 and 20 cm.
AT-64	Taylor, A. (Groningen) Pottasch, S. (Groningen) Seaquist, E. (Toronto)	Monitoring of nova Vulpeculae 1984 No. 2. 2, 6 and 20 cm.
AT-66	Turner, J. (CFA) Ho, P. (CFA)	HI mapping of Maffei 2. 21-cm line.
AT-68	Torrelles, J. (UNAM) Rodriguez, L. (UNAM) Canto, J. (UNAM) Ho, P. (CFA)	Broad ammonia emission from L1551 and Cep A. 1.3-cm line.
AU-22	Uson, J.	Background sources contaminating measurements of the Sunyaev-Zeldovich effect. 2 and 6 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NSF)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-119	van Breugel, W. (Calif.,Berkeley) Heckman, T. (Maryland) Miley, G. (STScI)	Radio and optical shells in PKS 0634-206. 20 cm
AV-123	van Breugel, W. (Calif., Berkeley) van Gorkom, J. (Princeton) Heckman, T. (Johns Hopkins) Miley, G. (STScI)	HI observations of Minkowski's object in the cluster of galaxies A194. 21-cm line.
AV-125	van Gorkom, J. (Princeton) Ekers, R. Wrobel, J. (NMIMT) Schweizer, F. (Carnegie)	Search for neutral hydrogen in two nearby radio galaxies: Fornax A. 21-cm line.
AV-131	Vilhu, O. (Colorado) Caillault, J. (Colorado)	Radio and X-ray emission in contact binaries: XY Leo. 6 cm.
AW-117	Wilson, T. (MPI, Bonn) Walmsley, C. (MPI, Bonn) Johnston, K. (NRL) Henkel, C. (MPI, Bonn)	2-cm formaldehyde in Orion. 2- cm line.

No.	Observer(s)	Program
AW-140	Wootten, H. A.	Ammonia synthesis of a dense core with outflow in the Rho Ophiuchius cloud. 1.3-cm line.
AW-142	Wills, B. (Texas)	Radio beaming and quasar-emission lines. 6 and 20 cm.
AW-144	Wilking, B. (Missouri) Mundy, L. (Caltech) Schwartz, R. (Missouri)	The circumstellar environment of the young star LKHα 234. 1.3 cm.
AY-8	Yusef-Zadah, F. (Columbia) Morris, M. (UCLA)	The Galactic Center "arc". 2, 6 and 20 cm.
AY-11	Yusef-Zadah, F. (Columbia) Morris, M. (UCLA) Senadakas, J. (MPIR) Klein, U. (MPIR) Wielebinski, R. (MPIR) Lasenby, A. (Cambridge)	The negative latitude extension of the arc near the Galactic Center. 6 and 20 cm.
AZ-24	Zheng, X. (SAO/Nanking U.) Ho, P. (CFA) Moran, J. (CFA)	Clumping and rotation in the molecular cloud OMC2. 1.3-cm line.
AZ-29	Zensus, A. (Caltech) Cohen, M. (Caltech) Readhead, A. (Caltech)	Radio galaxies 3C 123 and 3C 303. 1.3 cm.
VAH-37	Ho, P. (CFA) Turner, J. (CFA) Bartel, N. (CFA)	NGC 253. 6-cm, phased array, MK III, VLB.
VB-54	Backer, D. (Calif., Berkeley) Sramek, R.	Phase referencing to Sgr A. 6-cm phased array, MK III, VLB.

F. SCIENTIFIC HIGHLIGHTS

Exceptional Outburst from Cyg X-3

Since its discovery in 1972, the galactic X-ray binary Cyg X-3 has been known to undergo irregular large flaring events in the radio similar in character to extragalactic sources though shorter in time scale and smaller in size. This past October the daily Cyg X-3 monitoring program at the USNO Green Bank interferometer detected another large outburst similar to ones that occurred in September/October 1982, 1983, and 1984. Target of opportunity VLA observations during October, 1985 provided much improved coverage of the event, and the extensive data, once fully analyzed, promise to significantly improve constraints on the expansion model. The data appears to confirm an explosion velocity of about 0.3c and an outburst period of nearly one year. Newly acquired 90-cm observations will check on the λ^{-2} scattering property of the medium, as well. VLBI observations of the flaring source reaffirmed the jet-like morphology of the source and the 4.95-hour periodicity of the quiescent radio emission.

Cyclopropenylidene

Two 140-ft telescope observing programs have recently focussed on the interstellar organic ring molecule, C_3H_2. The ubiquitous occurrence of this molecule in the Galaxy makes it an important new tracer of physical and chemical conditions. The 2_{20}-2_{11} line of para-C_3H_2 was detected at 21.6 GHz to be quite strongly in absorption in cold dust clouds, placing narrow constraints on the range of densities over which C_3H_2 is seen. This transition, together with the fundamental resonance line of ortho-C_3H_2 at 18.3 GHz makes C_3H_2 one of the small group of molecules which may be used for general diagnostic purposes in the ISM. In addition, 140-ft observations have detected the 18.3-line in absorption in Cen A, suggesting that C_3H_2 may be widespread enough to study in many galaxies.

Comet Halley

OH observations of Comet Halley with the VLA in mid-November mapped the distribution of OH molecules in a cometary coma for the first time. The detailed maps show a non-uniform distribution, which, although completely unexpected, supports prevailing models of a cometary crust and the dissociation of water that has been vaporized from the cometary core. No OH was detected within the central portion of the coma out to a radius of 5×10^4 km in support of the view that the H_2O expelled from and surrounding the cometary nucleus is not immediately dissociated into hydrogen and detectable OH. Most of the OH emission, extending out to 10^5 km from the nucleus, was distributed in clumps. At a lower intensity level, OH emission was broadly distributed out to a radial distance in excess of 5×10^5 km. The OH observations have stimulated the search for the same effects in other molecules.

Inner Solar Wind

Interplanetary scintillation observations of 3C 279 within two solar radii of the center of the sun were made with the VLA in early October in an unusual opportunity to probe the physical conditions in the inner solar wind. Results from an earlier 1983 experiment, which was only able to follow 3C 279 to a distance of 3.2 R_O from the limb, mapped the variation of solar-wind velocity and its turbulence spectrum along the 3C 279 trajectory. Surprisingly, the observations showed a very rapid wind acceleration between 3 and 4 R_O and a very high anisotropy in that same range. The October, 1985 observations were intended to confirm the earlier results and to extend them significantly closer to the solar limb. Both the timeliness of the observing opportunity and the unexpected 1983 results required the special use of several VLA baselines beyond the standard C configuration.

Fornax A

VLA, 4-frequency, hybrid array observations with full u-v plane coverage are being accumulated of the strong radio galaxy, Fornax A, as a follow up to preliminary observations which indicate extremely complex filamentary structures in the outer lobes. The proximity and luminosity of Fornax A make it one of the few radio sources for which VLA resolutions can be useful in determining the structure and internal properties of the filaments. The filamentary lobe structure, totally unexpected on the basis of earlier low-resolution work, shows many unusual looping, curved features that are morphologically dissimilar to the fine structure of Cyg A. Puzzling low-polarization regions are also apparent which are not easily explainable in terms of internal Faraday rotation depolarization. Suggested explanations for the features include expanding shocks which are created in the lobe environment by outward flowing energetic beams, or narrow channels of rapidly cooling plasma which may be affected by the presence of longitudinal magnetic fields.

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. GREEN BANK ELECTRONICS

5 GHz, 7-Feed Receiver

A multi-feed receiver is being developed which will significantly improve continuum mapping capabilities of the 300-ft telescope. The receiver is designed to cover the frequency range 4.6-5.1 GHz. Seven feeds are arranged in a filled circular array, connected to cooled, dual-circular polarizers. All fourteen of the cooled FET amplifiers have been completed and installed, and cooling tests of the

refrigeration system have been performed. The cool-down time is satisfactory, and the refrigerator capacity is sufficient. Noise measurements have been performed on two receiver channels in broadband continuum mode, giving 38 and 40 K noise temperatures. This is somewhat higher than expected, and tests are being done to isolate the cause. The prototype feed was tested on the antenna test range, found satisfactory, and the remaining feeds are being constructed. During the next quarter, integration of the remainder of the system will continue, and extensive system tests will begin.

300-ft Spectral Processor/Control Computer

A combined project to replace the 300-ft control computer and to build a modern spectrometer is underway. The spectrometer will provide 2048 total frequency points in up to two channels of 40-MHz maximum bandwidth, or up to eight channels of 10-MHz maximum bandwidth. Many features that will enhance pulsar observations are being designed into the spectrometer, including 12 microsecond timing resolution, spectra dedispersion, spectra frequency and time-averaging capability, and interferenced excision capability. Early in the spectrometer project, it became apparent that it would be necessary to replace the telescope control/data acquisition computer with a modern system. A MASSCOMP super-microcomputer system has been selected as the new control computer, and development of the required real-time control software continues. The ULO interface to the new control computer is complete and ready for tests. The other major interfaces between the MASSCOMP and existing equipment are at various stages of completion. The data-acquisition system for receiver monitoring and the UT clock system have been purchased and are being tested. The spectrometer hardware development continues. The prototype memory addressing card has been evaluated. Due to some timing problems, some redesign will be necessary and is proceeding. Preliminary work on the memorycard was done, and many of the details on signal distribution were worked out. Critical parts of the timing generator module have been breadborded and tested. The integration and testing of this module into one or two boards remain to be done.

Lateral Focus, 300-ft Telescope

At the 300-ft telescope, there is a significant north-south displacement of the focal point as the telescope is moved away from the zenith. Measurements using a special offset feed arrangement at 4.75 GHz have shown that the addition of north-south receiver motion could result in large improvements in the aperture efficiency at large zenith angles. A mechanism has been designed and installed on the telescope that allows that motion of the Sterling mount. The receiver mount is currently locked in its normal position, pending installation and testing of the drive electronics. Preliminary testing of the drive motors has been done. The focal point safety interlock logic has to be changed in order to protect the hardware from the additional freedom of motion, and design work on that aspect is underway. Design work on the positional readouts and the required computer interface is proceeding.

I. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

On June 1 work began on the further development and construction of thirty 8.4-GHz receivers for use on the VLA for reception of telemetry signals from the Voyager 2 spacecraft. The VLA will be used for reception of television pictures of Neptune during a brief period centered on August 24, 1989. A schedule for construction of the front-ends has been made and shows delivery of a first unit by January, 1986 and last unit by October, 1987. The first three front-ends will utilize FET amplifiers; the construction of the amplifiers has started. HEMT devices will be evaluated between January and April, 1986, and a decision as to whether to use FET or HEMT devices will be made in June, 1986.

During this quarter, all parts for six front-ends and most inexpensive parts for all thirty front-ends have been received. Several types of FET's have been evaluated, and the Mitsubishi MGF1412 has been selected as the FET of choice if HEMT's are not used.

HEMT Device Development

HEMT devices from the University of Illinois and from the Dexcel Division of Gould were evaluated at 8 GHz this quarter. Neither device gave as good a performance as GE or Cornell devices previously tested. Additional devices from GE are expected in early 1986.

A four-stage HEMT/FET amplifier using chip/microstrip construction was completed and gives a noise temperature ~100 K over the 22-25 GHz frequency range. Cryogenic failure of solder and epoxy joints has been experienced and a modified fabrication technique is being evaluated.

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-m 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.

One-eighth of the final system has been completed, and 90% of the software is complete. Tests are in progress to measure the RMS fluctuation as a function of integration time and to measure the shape of artificial spectral lines. The system is giving theoretical fluctuation for integration times up to a few hours but has higher than theoretical fluctuation for integration times of the order of a day. Tests and further development will continue.

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.

During this quarter: (i) The replacement of a diode chip in a defective 80-120 GHz mixer has been attempted--so far a chip as good as the original has not been found. (ii) Work has begun on three 225-GHz radiometers for millimeter array site evaluation. (iii) Work has begun on an 80-120 GHz test mixer for evaluating the whiskerless Schottky diodes being developed under the University of Virginia contract.

Work on the 130-170 GHz and 270-290 GHz mixers is on hold until time is available.

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.

Experimental junctions for 70-120 GHz are being fabricated to our design by IBM (Watson Research Laboratory) under a joint study agreement, and should be delivered early in 1986. A final batch of junctions has been received from Hypres under an old NRL-NASA contract, and will be evaluated in the forthcoming quarter.

Work continues in collaboration with the University of Virginia on the construction of apparatus for making all-niobium junctions. We hope these will be suitable for operation at least to 340 GHz.

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 "multibeaming" would greatly advance the speed or sensitivity of millimeter-wave astronomy. Planar log-periodic antennas are being studied using lower-frequency scale models, and appear suitable as the basic elements of an array. Coupling between the mixer diode and the antenna is being studied. A next step may be to construct a small (seven element), two-dimensional array for operation at 6-8 GHz to study the effects of the interaction between adjacent elements.

Millimeter Local Oscillator Sources

Millimeter-wave-frequency multipliers developed at NRAO are now used as local oscillators for virtually all observations at the 12-m telescope. Planar (whiskerless) Schottky diodes being developed under the University of Virginia contract promise improved performance and reliability in the future.

In the last quarter we have started using the scanning electron microscope at the University of Virginia in assembling multipliers, and have been able to obtain consistently flatter frequency response in the 200-290 GHz range. Improved triplers have been supplied to Tucson. We have also constructed and tested a remote-controlled version of the 280-360 GHz quasi-optical tripler for the 12-m telescope.

J. TUCSON ELECTRONICS

SIS receiver

We have encountered many problems with the SIS receiver. The main difficulties have been with the cryogenic system, and these have now been solved. The receiver will be tested on the telescope at the first opportunity.

70-120 GHz Schottky Mixer Receiver

This receiver has given reliable performance over the past few months. The continuum performance of the receiver is about 1 Jy/sec, a value close to theoretical. Gunn oscillators have been purchased to replace the klystrons in this receiver. These will be installed when time permits.

345-GHz Receiver

This receiver will be used for observations in March, 1986. With a 345-GHz mixer installed, this reciver will cover the range 330-360 GHz, and by changing mixers the range 280-310 GHz may be covered.

8-Feed System

A conceptual design for an 8-feed array receiver is being refined, and we hope to start construction on this receiver soon.

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 effected directly. For example, at 44 GHz a 20" pointing error causes a 30% change in amplitude.

When the VLA antennas are heated by the sun at a low-elevation angle, differential temperatures of up to 5°C 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 arc min. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Nineteen antennas currently have insulation installed and coating of all antennas will be finished in 1987.

Another, lesser, pointing problem which will be addressed in the future is the occurrence of tilts of up to 20 arc secs 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.

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.

Four 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, the other a quad dipole type. These are installed on two antennas and testing to continue during the next quarter. With the new feeds installed near the focus of the antenna locally generated radio frequency interference became a significant problem (see RFI Improvements).

VLA 300-MHz Receiver

Observations of a large number of astronomical objects would benefit from a lower observing frequency that 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 arc min 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 interferency, both locally generated at the VLA and from external sources, will be a significant problem.

Ten 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, modification to some modules has been undertaken.

VLA 8-GHz Receivers

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 which will probably be a GaAs FET amplifier or an improved HEMT (High Electron Mobility Transistor) amplifier.

Two 8.4 GHz front-end have been received from the Central Development Laboratory in Charlottesville and have been installed on Antennas 20 & 21. Interferometer measurements with Antennas 20 and 21 on both Voyager I and II have been completed with the appropriate signal to noise ratio, and 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 next X-band system is scheduled for the second quarter in 1986.

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 was 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 at

327 MHz. When the new 75-MHz feed were installed, it appeared as though these module modifications did not reduce the locally generated RFI to a reasonable limit. Two RFI enclosures for the vertex mounted "B" racks have been specified. These RFI enclosures have been ordered, with delivery, installation and testing to start late in the next 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.

K-Band Maser Replacement

A prototype, HEMT, 22-GHz amplifier has been delivered from the Central Development Laboratory. This amplifier was installed in Antenna 23 in the "C-D" IF. The measured system temperature was 115 K at 22.485 GHz. New waveguide between the dewar and the feed system will be fabricated and installed, and is expected to reduce the system temperature by 10 K.

L. CHARLOTTESVILLE COMPUTER DIVISION

IBM Removal/Convex Installation

On December 20, the IBM 4341 system was removed. In its place, a Convex C1 computer system was installed. The changeover was made because the older IBM system was no longer an attractive system for the NRAO's needs and because it was too expensive to operate. The new system is technically very attractive, and, including capitalization, is substantially less costly. A portion of the system will be made available to the University of Virginia under a suitable financial arrangement.

The Convex is a vector register machine analogous to the CRAY-1 or the CRAY X/MP. It has vector registers, constant stride loading, gather/scatter and can do

scalar operations while vector operations are in progress. The machine has a capacity of about four times a VAX 11/780 in scalar and about 3 times a VAX 11/780 + array processor in vector work. AIPS has already been run on the Convex as a benchmark. The C1 will be used both for AIPS processing and for general-purpose computing.

M. SUPERCOMPUTER INITIATIVE

Cray Project

AIPS processing is continuing on the CRAY X-MP computer at Digital Productions in Los Angeles. During the period November 15 to December 10, intense use of the CRAY demonstrated that the AIPS system in that supercomputer is reliable, relatively complete and simple to use. Six projects, which were too large to be conveniently reduced on the NRAO VAX AIPS, were reduced during this period. The CRAY is about 15 times faster in cpu speed than the VAX plus AP, although the decrease in real time was less because of the heavy use of the CRAY by Digital Productions.

Request for Additional Supercomputer Access

The NRAO has submitted a request to the National Science Foundation for its supercomputing needs for 1986. Two thousand service units, the equivalent of 2,000 hours of CRAY X/MP time, have been requested on the Digital Productions system. If Digital Productions has a solid-state disk by the time use begins, the request will be reduced to 1,300 hours. In the event that this amount of time is not available on the Digital system, the use of alternative systems is also being investigated. Fifty hours has been requested on the Minnesota CRAY2 system to ascertain its suitability. Other systems are being considered as well.

N. AIPS

The new edition of the AIPS COOKBOOK and the reprinted edition of GOING AIPS appeared during the quarter.

An AIPS Workshop was held in Charlottesville on October 31 and November 1. There were 35 official participants from NRAO and 13 other institutions. The papers presented and the various discussions were all lively and useful.

The release of AIPS intended for 15 January 1986 incorporated a major change in the VAX directory structure and procedures. Due to the size of this change and a variety of other events, this release had to be postponed until 15 April 1986. We expect at that time to resume our regular release schedule. New things which will now be officially released in July include interpolation in loading images to the TV, a fairer queuing algorithm for the array processor, new output options for QMSPL, new clipping options for MOMNT, a new operation for mosaicing in COMB, a new task to do MEM on several overlapping fields, new options for deleting bad data in CLIP, new tasks to compress clean component and other tables, and a new task to plot intensities of one image against those of another image. Bug fixes in the

April release include correct position computation on rectangular images with large rotations, improved handling of the TV--particularly for the DeAnza and Comtal versions, and correct model computation in VBPLT.

O. VLA COMPUTER DIVISION

On-Line System

Development of the software for the new on-line system continued on the ModComp 16-bit system, while preparations were made for the arrival of the new 32-bit system early in the new year. An additional CPU, the replacement for the SPECTRE computer, was ordered for delivery in early 1986.

Pipeline System

The major change to the Pipeline system during the quarter was the replacement of the DISPLAY PDP-11/44 with a new VAX 11/750 system. The new system, named OUTBAX, serves as a display computer for the Pipeline, a true AIPS system and an image processing development system. It has an attached AIPS image computer, FPS array processor and sufficient disk space so that AIPS can be used effectively. Software to load Pipeline images for display and to transfer images into AIPS from the Pipeline has been completed. The Dicomed image recorder has been moved to the WORKER computer where it continues to function as before.

The mapping, cleaning and baseline-time functions of the Pipeline have been used extensively by observers, particularly for spectral-line projects. The SORTER computer is now used only for producing UVFITS tapes from DEC-10 databases since data is no longer filled into the Pipeline.

DEC-10 System

Added capability on the DEC-10 system came with the addition of two new, high-density (6250 bpi) tape drives, allowing more compact and efficient backups and exports of data. Testing of a UVFITS program for the DEC-10 was carried out.

VAX Systems

Disk capacity was expanded on each of the VAX 11/780's, bringing each system to over 2 Gigabytes. Additional VAX memory, received from Charlottesville after the memory upgrade on CVAX, has brought the total memory to 4 Megabytes, giving minor improvements to throughput.

P. VERY LONG BASELINE ARRAY

Project Management

In response to an increasingly soft funding prognosis, a number of new, tentative budget/project plans have been generated as an aid to determining the best

course to follow vis-a-vis number of antennas per year as against levels of effort in other areas. While it is desirable to avoid, if possible, renegotiation of the antenna contract (with probable attendant price increases), it is also desirable not to defer construction of correlator/data-processing facilities to the detriment of scientific utilization of the first few antennas. These alternative approaches are still under study by the Director, in consultation with senior scientific personnel.

Plans were completed for providing temporary space for VLBA construction activities both at the VLA and in Socorro.

Systems Engineering

This group continues to monitor the development of all subsystems to ensure conformity to specifications, compatibility of interfaces, and appropriateness of designs.

Accomplishments this quarter include contributions to the final design review for the antennas and to the selection of the hydrogen-maser contractor and negotiation of maser design details. Further details of the recording system design were established, as were standards for the construction of electronic equipment, including packaging, connectors, etc.

It was decided at the September VLBA design review that an alternative fringe tracking scheme might offer sufficient economies in the correlator to warrant a careful intensive study. In this approach, both fringe and delay tracking are accomplished at the stations by offsetting the reference signals from the station frequency standards. Half the multiplier/accumulator hardware, as well as all fringe-rotation logic, can then be eliminated from the correlator. Significant, though less drastic, side effects may be anticipated in the monitoring and control and post-processing subsystems. Accordingly, an ad hoc team representing the project areas involved will perform a preliminary evaluation and, if the results so indicate, carry out a design and prototype study.

Sites/Stations

The Bureau of Land Management (BLM) has formally agreed to use of the land required for the Pie Town, NM station. Required permits and utility arrangements have been negotiated. Bids for all construction, including site access, antenna foundation and buildings are now being evaluated.

Kitt Peak National Observatory (KPNO) has agreed informally to a location for the VLBA station on the mountain. Soil tests and site survey have been completed, so that a formal agreement may be worked out. Contractual arrangements were made with the Architect/Engineer (A/E) contractor, Stevens, Mallory, Pearl and Campbell, to carry out the site design.

At the Los Alamos, NM site, soil tests and site survey were completed. A formal request for use of land within the boundaries of Los Alamos National Laboratory was prepared for submission to the Department of Energy via NSF.

A three-acre station site near Brewster, WA has been chosen, and negotiations

for the property are under way. Proposals for soil tests and site survey are being evaluated.

RFI tests in Hawaii were completed. Informal negotiations were begun relative to locating a VLBA station on property on Mauna Loa near the Mauna Loa Observatory.

Two land owners have been approached informally relative to purchase or lease of a small parcel of land near Harvard's George R. Agassiz Station for the Fort Davis, TX VLBA site.

Array Operations Center (AOC)

Work started on the design of the AOC. The A/E contractor has worked on a concept for a building which includes space for both VLBA and VLA operations, so arranged that construction can be phased to the availability of funds. Discussions were begun with New Mexico Institute of Mining and Technology (NMIMT) relative to a site on its campus for the AOC.

Antennas

The contractor has essentially completed design work on the VLBA antenna. Items still incomplete include structural analysis of the apex structure (quadrapod), thermal analysis, and analysis of the pointing servo system. Cables are to be added to the apex structure for additional stability. Work is proceeding on all of the field alignment procedures for the antenna.

NRAO engineers prepared the specification for the subreflector, and an RFP was forwarded to 18 potential bidders. Bids are expected in late January, 1986. Design of the feed cone awaits final engineering checks.

Electronics

A prototype of the 8.4-GHz feed was fabricated and tested. The design of the 1.5-GHz feed was completed, and construction of a scale model was started.

The 10.7-GHz front end for the Pie Town station has been completed and tested. Work is in progress on the 4.8-GHz unit. Three additional 1.5-GHz front ends were completed, for a total of four now available. The uncooled front ends for 330 and 610 MHz are packaged as a single unit. Assembly of the first such unit has been completed, and testing will begin in January, 1986. Note that the above front ends cover all of the frequency bands to be included in the initial outfitting of each station.

Design of the monitoring and control arrangement for the front ends has been improved so that each cooled unit will have a small monitor panel with local controls to facilitate initial adjustment and diagnosis of problems during operation. Each such unit will be connected to an interface with the Monitoring and Control bus for communication with the station computer. A prototype front-end interface unit has been constructed and tested.

In the local oscillator area, three 2-16 GHz synthesizer units are nearing completion, one to be kept for laboratory use and two for use in the Pie Town

station. Breadboard models of the two modules that transmit the reference signal from the hydrogen maser to the antenna vertex room (and also incorporate the round-trip phase-measuring scheme for compensating changes in electrical lengths of cables) are nearing completion and will be tested next quarter. A contract for ten hydrogen masers has been signed with Sigma Tau Standards Corporation of Tuscaloosa, Alabama, after detailed evaluation of proposals, including visits to two of the bidders' laboratories.

In the SIS mixer development for the 43-GHz front end, assembly of the test system has continued, and the mixer block has been designed. Fabrication of junctions for the first tests will start soon under contract with National Bureau of Standards.

Data Recording

The plan being followed at Haystack Observatory calls for completion of a prototype Data Acquisition System (DAS) by July, 1986. It will be delivered to the VLA in time for integrated system tests of station equipment prior to final installation at the Pie Town station. Any deficiencies discovered during these tests will be remedied prior to the move to Pie Town.

This past quarter, detailed design work continued on the VLBA recorder proper. Prototypes of the electronic modules, including the baseband converter, the IF Distributor and the Formatter, are under construction. A number of the required submodules have been built and tested.

Monitoring and Control

Designs for the standard interface boards have been completed, incorporating the suggestions for off-board-determined addresses made at the Green Bank design review in September. Artwork is complete, and the production run for the Pie Town station can be made as soon as the required number of each type is known.

Some necessary utility subroutines (for formatting times, angles, etc.) have been written for the station computer software system. A program has been written which converts a text string observation request to a convenient form for computer use. The antenna pointing program has been started, as has a program which precesses standard epoch positions to positions of date. Work continues on the software drivers for the monitor and control bus. Development of a program to run on an IBM-compatible PC to permit it to serve as the Antenna Control Test Unit (ACTU) is about 50% complete.

Correlator

The reorganized VLBA Correlator group began investigations of a range of design alternatives, including high-speed and/or recirculating approaches, correlation in the spectral domain, and table look-up techniques for fringe-rotation and correlation.

Recently, the group decided to develop in more detail a particular combination of these concepts, based on spectral-domain correlation and similar in some ways to the "FX" correlator at the Nobeyama Radio Observatory. In this approach, almost

all signal processing is applied directly to the individual antenna data streams, and only a final pairwise multiplication is required to form the interferometer spectrum. The resulting efficiency promises major cost reductions if certain inflexibilities in the hardware organization can be overcome.

Q. PERSONNEL CHANGES

New Hires

Roger G. Noble	Vis Sci Prog Analyst	10/03
Robert Braun	Research Associate	10/09
Joseph H. Greenberg	Electronics Engineer I	12/02

Terminations

Patrick E. Palmer	Visiting Scientist	10/04

Changes in Status

Robert E. Mauzy, Jr.	Electronic Engineer I to Electronic Engineer I/ Asstistant Division Head	10/01
Philip R. Jewell	Scientific Associate I to Systems Scientist	11/01

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