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NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

July 1, 1987 - September 30, 1987

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the third quarter of 1987.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1485.25	1807.50	481.5	1792.7
Scheduled maintenance and equipment changes	132.50	228.00	22.5	226.6
Scheduled tests and calibrations	590.25	159.00	1704.0	194.8
Time lost	98.75	54.00	24.0	-
Actual observing	1437.25	1770.00	457.5	1669.0

B. 140-FT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
C-248	Crutcher, R. (Illinois) Goodman, A. (CFA) Heiles, C. (Berkeley) Kazes, I. (Meudon) Myers, P. (CFA) Troland, T. (Kentucky)	OH Zeeman observations at 18 cm.
E-55	Elmegreen, B. (IBM) Elmegreen, D. (Vassar)	Observations of HI in a giant atomic cloud near M17.
T-217	Turner, B. Kazes, I. (Meudon)	Search at 9 cm for CH in OH megamaser galaxies.
T-229	Turner, B. Brown, J. (Oxford) Steimle, T. (Arizona State) Woodward, D. (CFA)	Search at 25 cm for interstellar CD.
T-230	Troland, T. (Kentucky) Heiles, C. (Berkeley)	Search at 5 cm for Zeeman sensitive excited state OH lines from molecular outflow sources.
W-201	Walmsley, C. M. (MPIR, Bonn) Batrla, W. (Illinois) Observations at 9.98 GHz of methanol	absorption in interstellar clouds.

The following pulsar program was conducted during this quarter.

No.	Observer(s)	Program
B-484	Backer, D. (Berkeley) Clifton, T. (Berkeley) Foster, R. (Berkeley) Kulkarni, S. (Caltech) Taylor, J. (Princeton)	Timing observations at 1400 MHz of PSR 1821-24 and other millisecond pulsars.

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
EVN - European Network
F - Fort Davis 85 ft
G - Green Bank 140 ft
H - Hat Creek 85 ft
I - Iowa 60 ft
Jm - Jodrell Bank 250 ft
Jb - Jodrell Bank Mk II
Km - Haystack 120 ft
Lb - Bologna 25 m
Lm - Medicina 32 m
N - NRL Maryland Pt 85 ft
O - Owens Valley 130 ft
Sn - Onsala 20 m
So - Onsala 25 m
R - Crimea USSR 30 m
Wn - Westerbork n=1-14x25 m
Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
A-14V	Alef, W. (MPIR, Bonn) Matveyenko, L. (IFSR, USSR) Pauliny-Toth, I. (MPIR, Bonn) Preuss, E. (MPIR, Bonn) Kellermann, K. Romney, J.	Observations at 2.8 cm of the structure of NGC 1275 with telescopes B, F, G, H, Km, Lm, O, and R.
A-17V	Alef, W. (MPIR, Bonn) Preuss, E. (MPIR, Bonn) Kellermann, K.	Studies at 6 cm of the structural variability in 3C 390.3 and 3C 111 with telescopes B, G, Lm, So, and Yn.
B-74V	Barthel, P. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech)	Third-epoch observations at 6 cm of a complete sample of compact objects with telescopes B, G, H, I, Jm, Km, Lm, O, So, Wn, and Yn.
B-79V	de Bruyn, A (NFRA) Brouw, W. (NFRA) Brouwer, F. (Delft) Schilizzi, R. (NFRA)	Astrometric observations at 6 cm of M 81 and SS 433 with telescopes B, G, Jm, Km, Lm, Wn, and Yn.

No.	Observer(s)	Program
B-81V	Bartel, N. (CFA) Rogers, A. (Haystack) Shapiro, I. (CFA)	Observations at 6 cm of the expansion and morphology of SN 1979C with telescopes B, G, O, and Yn.
F-12V	Flatters, C. (MPIR, Bonn)	Polarization observations at 2.8 cm of the quasar 4C 39.25, with telescopes B, F, G, H, Km, Lm, and O.
G-50V	Gorenstein, M. (CFA) Corey, B. (Haystack) Falco, E. (CFA) Rogers, A. (Haystack) Shapiro, I. (CFA)	Monitoring at 6 cm of the A and B images of the core of 0957+561 with telescopes B, G, Km, Lm, O, Wn, and Yn.
G-51V	Gurvits, L. (IFSR, USSR) Kardashev, N. (IFSR, USSR) Pauliny-Toth, I. (MPIR, Bonn) Popov, M. (IFSR, USSR) Schilizzi, R. (NFRA) Kellermann, K.	Observations at 6 cm of the radio structure of quasars which are ten times younger than the universe with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
H-36V	Hooimeyer, J. (Leiden) Barthel, P. (Caltech) Schilizzi, R. (NFRA)	Observations at 6 cm for superluminal motion in two large quasars with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
M-63V	Mutel, R. (Iowa) Phillips, R. (Haystack)	Monitoring at 2.8 cm of superluminal motion in BL Lacertae with telescopes B, F, G, H, Km, Lm, and O.
M-78V	McHardy, I. (Leicester) Gear, W. (Lancashire Polytech) Marscher, A. (Boston)	Observations at 2.8 cm of the Blazar 1156+295 with telescopes B, G, H, Km, Lm, and O.
M-87V	Marr, J. (Berkeley) Backer, D. (Berkeley)	Observations at 6 cm of the compact structure in NGC 1275 with telescopes B, F, G, H, I, Jb, Km, Lb, N, O, Sn, 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 B, G, H, Km, Lm, and O.

No.	Observer(s)	Program
P-80V	Pauliny-Toth, I. (MPIR, Bonn) Cohen, M. (Caltech) Zensus, A. (Caltech)	Observations at 2.8 cm of PKS 2134+004 with telescopes B, F, G, H, Km, Lm, and O.
W-42V	Walker, R. C. Unwin, S. (Caltech) Benson, J.	Monitoring at 6 cm of superluminal motions in 3C 120 with telescopes A, B, F, G, H, I, Km, N, O, So, and Yn.
X-51V	Alef, W. (Puerto Rico) Altschuler, D. (Puerto Rico)	Observations at 2.8 cm of 1722+330 with telescopes EVN and G.
Z-12V	Zensus, A. (Caltech) Porcas, R. (MPIR, Bonn)	Observations at 2.8 cm of 3 weak quasars with telescopes B, G, Km, and O.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-82	Aller, H. (Michigan) Aller, M. (Michigan) Payne, H.	Observations at 880, 1400, and 2700 MHz of low frequency variable sources.
B-412	Burke, B. (MIT) Conner, S. (MIT) Heflin, M. (MIT) Langston, G. (MIT) Lehar, J. (MIT)	Observations at 6 cm to continue the MIT-Green Bank Survey at $\delta = 20° < \delta < 45°$.
C-238	Condon, J. Broderick, J. (VPI & SU) Seielstad, G.	Sky survey at 4.8 GHz covering $-2° < \delta < +77°$.
O-32	O'Dea, C. (NFRA) Balonek, T. (Colgate) Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)	Polarization and flux density measurements of variable sources at 2695 MHz.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
D-156	Dickinson, D. (Lockheed) Turner, B.	Observations at 18 cm of the evolutionary status of OH/IR stars.

No.	Observer(s)	Program
K-305	Kerr, F. (Maryland) Henning, P. (Maryland)	Search for galaxies behind the Milky Way, by the study of HI.
M-277	Magri, C. (Cornell) Haynes, M. (Cornell)	Search for HI from Sa and Sc galaxies as a part of a study of the nature of galaxian spiral structure.
R-239	Richter, O-G. (STScI) Huchtmeier, W. (MPIR, Bonn)	Complete high sensitivity HI survey of SO galaxies contained in the Shapley-Ames Catalog.
S-312	J. Schmelz (Applied Research	Observations of 18 cm satellite lines in OH megamasers.
Y-2	Yamanaka, J. (Laval) Gregg, M. (Carnegie Inst.)	Observations of HI in the Bootes Void.

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
D-159	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
H-224	Heiles, C. (Berkeley) Koo, B. (Berkeley) Reach, W. (Berkeley)	Investigation of selected IRAS "cirrus point sources" for CO emission.
H-225	Heiles, C. (Berkeley) Koo, B. (Berkeley) Reach, W. (Berkeley)	Investigation of selected IRAS diffuse clouds for CO emission.
H-235	Heiles, C. (Berkeley) Lizaw, S. (Berkeley) Shu, F. (Berkeley) Rodriguez, L. (Mexico) Mirabel, I. (Puerto Rico)	Search for neutral stellar winds.
H-240	Hogg, D.	A search for CO associated with stellar wind bubbles.
L-221	Liszt, H.	Study of CO in Zeta Oph and Sgr A.
T-226	Turner, B. Bally, J. (Bell Labs)	Confirmation of interstellar PN.

No.	Observer(s)	Program
T-232	Turner, B. Feldman, P. (Herzberg) Amano, T. (Herzberg) Lee, S. (Herzberg) Bally, J. (Bell Lab)	Search for protonated cyanoacetylene (HC_3NH^+).
V-64	Vallee, J. (Herzberg) Avery, L. (Herzberg)	Study of star formation in the nearest molecular clouds.
W-227	Walker, C. (Arizona) Lada, C. (Arizona) Maloney, P. (Arizona) Young, E. (Arizona)	Search for infall around candidate protostars using CS J=2-1 transition.

E. VLA OBSERVING PROGRAMS

No.	Observer(s)	Program
AA-64	Antonucci, R. (STScI) Barvainis, R.	Testing the synchrotron hypothesis for quasar infrared emission. 20 cm.
AA-65	Andre, P. (CEN Saclay) Montmerle, T. (CEN Saclay) Feigelson, E. (Penn State)	Three young radio stars in the Rho Ophiuchi cloud. 1,3, 2, 6, 20 and 90 cm.
AA-70	Altschuler, D. (Puerto Rico) Hummel, E. (MPIR, Bonn) Loiseau, N. (MPIR, Bonn)	Galaxies with multiple nuclei. 20 cm.
AA-71	Aller, H. (Michigan) Aller, M. (Michigan) Hughes, P. (Michigan)	Polarization and spectra of the cores of active extragalactic objects. 2, 4, and 6 cm.
AA-72	Antonucci, R. (STScI) Barvainis, R. Wills, B. (Texas) Wills, D. (Texas)	Extended radio emission around newly discovered blazars. 20 cm.
AA-73	Akujor, C. (Nigeria)	PKS 0114+074. 6, 20 and 90 cm.
AB-408	Bookbinder, J. (Colorado) Caillault, J. (Colorado) Gary, D. (Caltech) Giampapa, M. (Nat. Solar Obs.) Golub, L. (SAO) Linsky, J. (Colorado) Gibson, D. (NMIMT)	Survey of M dwarf stars. 1.3, 2, 6, and 20 cm.

No.	Observer(s)	Program
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring flux of HD 193793 and P Cygni. 2 and 6 cm.
AB-434	Braun, R. Perley, R. Gull, S. (Cambridge) Rudnick, L. (Minnesota)	Physical processes in Cas A. 6 and 20 cm.
AB-436	Bietenholz, M. (Toronto) Kronberg, P. (Toronto)	High resolution studies of the Crab Nebula. 20 cm.
AB-440	Brown, R.	The extended structure of 0235+164. 18 and 20 cm.
AB-444	Barsony, M. (Caltech)	Imaging of S87 over three orders of magnitude in spatial scale. 6 and 18 cm.
AB-446	Bookbinder, J. (Colorado) Stencel, R. (Colorado) Drake, S. (Goddard (SASC)) Linsky, J. (Colorado) Brown, A. (Colorado)	Studies of the winds of luminous M stars Alpha Ori. 2 cm.
AB-448	Baldwin, J. (MRAO) Dingley, S. (MRAO)	The redshift cutoff for radio galaxies at z greater than 2. 20 cm.
AB-449	Barthel, P. (Caltech) Lonsdale, C. (Haystack) Miley, G. (STScI)	Medium resolution observations of high redshift quasars. 20 cm.
AB-451	Becker, R. (Calif., Davis) Helfand, D. (Columbia)	Compact radio sources in supernova remnants: G351.2+0.1. 6, 20 and 90 cm.
AB-452	Boisse, P. (ENS, Paris) Kazes, I. (Meudon) Bergeron, J. (IAP) Dickey, J. (Minnesota)	Mapping 0446-208 and nearby galaxy. 20 cm.

No.	Observer(s)	Program
AB-454	Bridle, A. Browne, I. (NRAL) Burns, J. (New Mexico) Dreher, J. (MIT) Hough, D. (JPL) Laing, R. (RGO) Lonsdale, C. (Haystack) Scheuer, P. (Cavendish Lab) Wardle, J. (Brandeis)	Investigation of sidedness of jets in high luminosity sources. 6 cm.
AB-456	Burke, B. (MIT) Hewitt, J. (Haystack) Roberts, D. (Brandeis)	Time variation of 0957+561 A,B. 6 cm.
AB-457	Brown, A. (Colorado) Bookbinder, J. (Colorado)	Reference sources near T Tauri. 6 cm.
AC-149	Clarke, D. (New Mexico) Burns, J. (New Mexico) Norman, M. (LANL) Christiansen, W. (North Carolina)	Search for active magnetic field effects in extragalactic radio sources: 3C 388. 6 and 20 cm.
AC-166	Carilli, C. (MIT) Dreher, J. (MIT) Perley, R.	Further studies of Cygnus A. 20 and 90 cm.
AC-170	Chance, D. (STScI) Yusef-Zadeh, F. (Goddard)	Orion nebula. 20 cm.
AC-173	Cameron, R. (Mt. Stromlo) Parma, P. (Bologna) de Ruiter, H. (Bologna)	PKS 2149-158: a binary radio jet system. 6, 18 and 21 cm.
AC-187	Campbell, B. (New Mexico) Simon, M. (SUNY)	High resolution studies of outflow young stellar objects. 2 and 6 cm.
AC-188	Campbell, B. (New Mexico) Stocke, J. (Colorado)	Inner disk and jet structure in L1551 IRS 5. 1.3, 2, 6 and 20 cm.
AC-193	Cowan, J. (Oklahoma) Branch, D. (Oklahoma)	Search for radio emission from Type II intermediate age supernovae. 20 cm.
AC-195	Clegg, A. (Cornell)	Possible small-scale ionized bipolar flows. 1.3 cm.

No.	Observer(s)	Program
AD-197	Drake, S. (Goddard) Elitzur, M. (Goddard) Linsky, J. (Colorado)	Further studies of red giants. 2 and 6 cm.
AD-199	Dulk, G. (Colorado) Bookbinder, J. (Colorado) McKean, M. (Colorado) Zlobec, P. (Trieste) Masserrotti, M. (Trieste)	Fine structures in solar active regions and Type I radio bursts. 1.3, 2, 6, 18, 20, and 90 cm.
AD-202	Djorgovski, G. (CFA) Gorenstein, M. (CFA) Perley, R.	Lensed QSO candidate 1145-071. 6 and 20 cm.
AD-204	Duric, N. (New Mexico) Dittmar, M. (New Mexico) Crane, P.	Multi-frequency, scaled array study of four normal spiral galaxies. 90 cm.
AE-51	Elitzur, M. (Kentucky) Hollis, J. M. (Goddard) Michalitsianos, A. (Goddard) Kafatos, M. (George Mason)	Search for emission at the SiO Maser position in R Aquarii. 6 cm.
AF-115	Feigelson, E. (Penn State) Schwartz, D. (CFA) Madejski, G. (CFA)	Radio structure of X-ray selected BL Lac objects. 20 cm.
AF-122	Fich, M. (Waterloo)	Compact flat spectrum sources in the outer galaxy. 6 cm.
AF-137	Feigelson, E. (Penn State) Montmerle, T. (CEN Saclay) Andre, P. (CEN Saclay)	Monitoring radio flaring stars in the Rho Oph cloud. 2, 6 and 20 cm.
AF-143	Fischer, M. (La Plata Jr. High) Gonzales, P. (La Plata Jr. High) Gibson, D. (NMIMT)	Globular cluster X-ray binary 4U1820-20. 20 cm.
AF-147	Fanti, C. (Bologna) Fanti, R. (Bologna) Schilizzi, R. (NFRA) Spencer, R. (NRL) van Breugel, W. (Berkeley)	Search for extended structure associated with CSS radio sources. 20 cm.
AF-149	Fix, J. (Iowa) Reynolds, S. (N. C. State)	A possible Crab-like supernova remnant in M33. 6 cm.

No.	Observer(s)	Program
AC-197	Claussen, M. (Massachusetts) Lo, K. (Illinois)	Distribution of luminous water masers in the nucleus of NGC 1068. 1.3 cm line.
AC-198	Claussen, M. (Massachusetts)	Structure of OH masers around RAFGL 2343. 2 and 18 cm line.
AC-199	Clifton, T. (Berkeley) Kulkarni, S. (Caltech)	Proper motion of PSR0748-28 and interstellar scattering of PSR 1849+00. 20 cm.
AC-201	Cohen, N. (Boston) Benson, P. (Wellesley) Feldman, P. (Herzberg) Little-Marenin, I. (Wellesley) Little, S. (Bentley College)	Sources near EU Andromedae. 1.3 and 6 cm.
AC-203	Cordes, J. (Cornell) Dewey, R. (Cornell) Hankins, T. (Dartmouth)	Gated astrometry of pulsars. 6 and 20 cm.
AC-204	Cordova, F. (LANL) Mason, K. (Mullard Space Sci. Lab)	Simultaneous radio and infrared observations of flares in Cyg X-3. 1.3 and and 2 cm.
AD-188	Drake, S. (Goddard) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in M supergiants Alpha Ori, Alpha Sco, and Alpha 1. 2 and 6 cm.
AD-194	Drake, S. (Goddard) Linsky, J. (Colorado) Shore, S. (NMIMT) Elitzur, M. (Goddard)	Radio emission from early-type magnetic stars. Further studies of red giants. 2, 6, and 20 cm.
AD-195	De Muizon, M. (Leiden Obs.) Oort, M. (Leiden Obs.) Roland, J. (Leiden Obs.)	SNR G70.7+10.2. 20 and 90 cm.
AD-196	Dickel, J. (Illinois) Mufson, S. (Indiana) Lasker, B. (STScI) Hester, J. (Caltech)	Filaments in IC 443. 18 cm.

No.	Observer(s)	Program
AF-152	Feigelson, E. (Penn State)	Mapping the radio galaxy PKS 0745-191. 2, 6 and 20 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Royal Obs.) Ade, P. (Queen Mary Coll.) Robson, I. (Lancashire Polytech) Nolt, I. (Oregon) Smith, M. (Royal Obs.)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20 and 90 cm.
AG-243	Giovannini, G. (Bologna) Feretti, L. (Bologna)	The extended source near Coma A. 90 cm.
AG-247	Garrington, S. (NRAL) Laing, R. (RGO) Leahy, J. (NRAL) Conway, R. (NRAL)	Origin of depolarization asymmetry. 6, 18 and 20 cm.
AG-248	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna)	Low frequency observations of NGC 4869. 90 cm.
AG-249	Greenhill, L. (Harvard) Moran, J. (CFA) Reid, M. (CFA)	The H_2O maser regions in M33. 1.3, 2, and 6 cm line.
AG-250	Gregorini, L. (Bologna) Padrielli, L. (Bologna) Parma, P. (Bologna)	Radio galaxies of intermediate strength. 6 cm.
AG-251	Gregory, P. (British Columbia) Duric, N. (New Mexico) Taylor, A. (NRAL)	New galactic variable radio sources. 1.3, 2, 6 and 20 cm.
AG-252	Goss, W. M. Viallefond, F. Boulanger, F. (Caltech) Peimbert, M. (UNAM)	Radio continuum survey of the spiral M101. 6 and 90 cm.
AG-257	Gibson, D. (MIT-Lincoln Labs)	AR Lacertae. 6 cm.
AH-195	Hjellming, R. Davis, R. (NRAL)	Recurrent nova RS Oph. 1.3 cm.
AH-234	Heeschen, D. Wrobel, J. (NMIMT)	Clumpy irregular galaxies. 6 cm.

No.	Observer(s)	Program
AH-247	Hummel, E. (MPIR, Bonn) Dettmar, R. (Bonn) Bajaja, E. (IAR) Wielebinski, R. (MPIR, Bonn)	Large and small scale structure of M 104. 20 cm.
AH-254	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (NRAL) Seaquist, E. (Toronto)	Three recent novae. 1.3, 2, 6, and 20 cm.
AH-270	Hummel, E. (MPIR, Bonn) van der Hulst, J. (NFRA) Sramek, R.	Monitoring NGC 4194 in search of supernovae. 2 and 6 cm.
AH-271	Hill, G. (Hawaii) Lilly, S. (Hawaii) Stockton, A. (Hawaii)	The radio source population at z = 0.5. 20 cm.
AH-275	Hughes, V. (Queen's)	The variable source CepA West. 2, 6, and 20 cm.
AH-276	Hanisch, R. (STScI) Batuski, D. (STScI) Burns, J. (New Mexico)	Head-tail radio sources in poor clusters of galaxies. 6 and 20 cm.
AH-278	Hewitt, J. (Haystack) Turner, E. (Princeton) Burke, B. (MIT)	The unusual ring-shaped source 1129+052: what is it? 1.3, 2, 6 and 18 cm.
AH-279	Hjellming, R.	Imaging the stable remnant of the recurrent nova RS Ophiuchi. 2, 6, and 20 cm.
AH-280	Hogg, D.	Search for variation in radio emission of WR star HD191765. 2, 6 and cm. 20 cm.
AH-282	Hutchings, J. (DAO) Neff, S. (Goddard) Gower, A. (Victoria)	Evolution of radio-loud AGN with distance and luminosity. 6 and 20 cm.
AJ-152	Johnston, K. (NRL) Russell, J. (NRL) de Vegt, C. (Hamburger Sternwarte)	Radio astrometric positions. 6 and 20 cm.
AJ-153	Johnston, K. (NRL) Florkowski, D. (USNO) de Vegt, C. (Hamburger Sternwarte)	Search for calibrators near radio stars. 6 cm.

No.	Observer(s)	Program
AJ-154	Johnston, K. (NRL) Hjellming, R. Vermeulen, R. (Leiden) Schilizzi, R. (NFRA)	Extended observations of SS 433. 1.3 and 20 cm.
AJ-155	Johnston, K. (NRL) Wade, C. Seidelmann, P. (USNO) Webster, W. (Goddard) Hobbs, R. (CTA)	Spatial distribution of 1 Ceres and 2 Pallas 2 cm emission. 2 cm.
AK-168	Kulkarni, S. (Caltech) Backer, D. (Berkeley) Clifton, T. (Berkeley) Middleditch, J. (LANL) Lyne, A. (NRAL)	M 28 pulsar investigation. 20 cm.
AK-170	Kundu, M. (Maryland) White, S. (Maryland) Schmahl, E. (Maryland) Pick, M. (Meudon)	Simultaneous microwave and meterwave solar imaging observations. 6, 20, and 90 cm.
AK-174	Kandalyan, R. (Byurakan Obs.) Wilson, A. (Maryland)	Two Seyfert galaxies suspected of variable radio emission. 6 and 20 cm.
AK-176	Kwok, S. (Calgary) Aaquist, O. (Calgary)	High resolution radio survey of compact planetary nebulae. 2 and 6 6 cm.
AK-177	Kronberg, P. (Toronto) Sramek, R.	Monitor M82. 1.3, 2, and 6 cm.
AK-178	Katgert, P. (Leiden) Oort, M. (Leiden)	Redshift dependence of linear sizes of ellipticals. 20 cm.
AK-179	Kawabe, R. (Nobeyama) Okumura, S. (Nobeyama) Ishiguro, M. (Nobeyama) Kanzawa, T. (Nobeyama) Fomalont, E.	The disk structure of H_2O masers in the bipolar flow source NGC 2071. 1.3 cm line.
AK-180	Kronberg, P. (Toronto) Zukowski, E. (Toronto)	Rotation measure maps of three radio-extended quasars. 2, 6 and 20 cm.
AL-139	Lang, K. (Tufts) Willson, R. (Tufts) Trottet, G. (Paris)	Solar noise storms. 90 cm.

No.	Observer(s)	Program
AL-142	Leahy, J. (NRAL)	Faraday rotation and depolarization in 3C 132. 6, 18, and 20 cm.
AL-143, 144,145	Lang, K. (Tufts) Willson, R. (Tufts)	Capella and VW Cephei; survey of cool stars. 2, 6 and 20 cm. Simultaneous observations.
AL-146	Leahy, J. (NRAL) Perley, R.	Bridges in nearby 3C sources. 20 and 90 cm.
AL-150	Lestrade, J-P. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.
AL-151	Langston, G. (MIT) Heflin, M. (MIT) Lehar, J. (MIT) Burke, B. (MIT)	High redshift observation of 21 cm absorption. 90 cm line.
AL-152	Langston, G. (MIT) Carilli, C. (MIT) Burke, B. (MIT)	Observations of core-jet radio sources from the MG-VLA snapshot survey. 6, 18, and 20 cm.
AL-153	Langston, G. (MIT) Heflin, M. (MIT) Burke, B. (MIT)	Four lens candidates detected with VLBI. 2 cm.
AL-154	Langston, G. (MIT) Heflin, M. (MIT) Burke, B. (MIT) Lawrence, C. (Caltech)	Time variation of 2016+112. 6 cm.
AL-158	Little, L. (Kent) Heaton, B. (Kent)	Twin beams from a young B star? 2 cm.
AL-159	Lynds, R. (NOAO) Petrosian, V. (Stanford)	Giant luminous arcs in two clusters of galaxies. 20 cm.
AL-160	Lestrade, J. (JPL) Niell, A. (JPL) Preston, R. (JPL)	Phase referenced VLBI observations of RS CVn binary systems. 4 cm single antenna MK III VLB.
AM-192	Masson, C. (Caltech) Lo, K. (Illinois) Claussen, M. (Massachusetts)	Proper motions in the galactic center. 6 cm.
AM-198	Mazzarella, J. (Michigan) Aller, H. (Michigan) Gaume, R. (Michigan)	Continuum structures in four double-nucleus Markarian galaxies. 20 cm.

No.	Observer(s)	Program
AM-205	Miley, G. (STScI) Chambers, K. (Johns Hopkins) van Breugel, W. (Berkeley)	Study of ultra-steep spectrum radio sources. 2 and 6 cm.
AM-212	Marscher, A. (Boston) Shaffer, D. (Interferometrics Inc.)	4C 39.25. 1.3, 2, 6 and 20 cm.
AM-213	McCarthy, P. (Berkeley) van Breugel, W. (Berkeley) Spinrad, H. (Berkeley) Djorgovski, G. (CFA)	Extremely distant radio galaxies. 2 and 6 cm.
AM-215	McHardy, I. (Leicester) Warwick, R. (Leicester) Cooke, B. (Leicester) George, I. (Leicester)	0414+009: An x-ray bright BL Lac with a radio trail in a distant clusters of galaxies. 6, 20, and 90 cm.
AM-218	Menten, K. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Wadiak, E. Johnston, K. (NRL)	Methanol masers. 1.3 cm line.
AM-221	Morganti, R. (Bologna) Fanti, C. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Jets in low luminosity radio galaxies. 6 cm.
AN-44	Norris, R. (CSIRO) Allen, D. (AAT) Roche, P. (UC, London)	Compact structure in obscured active galaxies. 6 and 18 cm.
AO-74	O'Dea, C. Baum, S. (Maryland)	Radio properties of giant galaxies in accretion flows. 2 and 6 cm.
AP-133	Preston, R. (JPL) Meier, D. (JPL) Jauncey, D. (CSIRO) Tzioumis, A. (Sydney)	Imaging of 0403-132 and 0405-123. 1.3 and 6 cm.
AP-134	Perley, R. Ekers, R.	Superluminal expansion of 3C 273 and 3C 279 on arcsecond scales. 2 and 6 cm line.
AP-135	Perley, R.	Rotation measure of 3C 295. 2 and 6 cm.

No.	Observer(s)	Program
AP-136	Pottasch, S. (Kapteyn Lab) Zijlstra, A. Bignell, R. C.	Additional measurements for a general survey of planetary nebulae. 6 cm.
AP-142	Pedlar, A. (NRAL) Saikia, D. (NRAL) Unger, S. (RGO) Whittle, M. (Virginia)	Polarization observations of Seyfert nuclei. 2 cm.
AP-144	Price, R. (Victoria) Gower, A. (Victoria)	Selected intermediate-redshift quasars. 2 cm.
AP-145	Phillips, J. (Queen Mary Coll.) Mampaso, A. (IAC) Zijlstra, A.	Core mapping of Type I planetary nebulae. 2 and 6 cm.
AR-154	Rucinski, S. (Toronto)	Coronal radio emission of late A/early F-type dwarfs. 2, 6 and 20 cm.
AR-161	Rodriguez, L. (UNAM) Canto, J. (UNAM) Curiel, S. (UNAM) Torrelles, J. (Inst. Ast. Andalucia) Ho, P. (Harvard)	Focusing of the Herbig-Haro 1-2 jet. 2 cm.
AR-163	Rodriguez, L. (UNAM) Garcia-Barreto, J. (UNAM) Gomez, Y. (UNAM) Moran, J. (CFA)	Angular expansion of NGC 6302. 6 cm.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Supernova SN 1980 in NGC 6946 and SN1979c in M100. 2, 6 and 20 cm.
AS-211	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Statistics of supernovae. 6 and 20 cm.
AS-268	Smith, H. (NRL) Simon, R. (NRL) Mozurkewich, D. (NRL)	A dense disk around NGC 2071: a selected bipolar flow. 2 and 20 cm.
AS-271	Seaquist, E. (Toronto) Bell, M. (NRC)	Absorption by H_2CO, HI and OH against the strong nuclear continuum source in Centaurus A. 6, 18 and 20 cm line.

No.	Observer(s)	Program
AS-280	Seaquist, E. (Toronto)	Expansion of the compact nebula Vy2-2. 1.3, 2, 6 and 20 cm.
AS-286	Stine, P. (Penn State) Weedman, D. (Penn State)	Relationship between radio and IR emission in starburst galaxies. 20 cm.
AS-290	Simon, R. (NRL) Johnston, K. (NRL)	Arcsecond scale maps of 3C 395. 6 and 20 cm.
AS-291	Saslaw, W. (Virginia) Cotton, W. Benson, J.	Galactic stars superimposed on background radio sources. 6 cm.
AS-293	Sramek, R. Skillman, E. (NFRA)	The SNR in NGC 5471. 6 cm.
AS-294	Strom, R. (NFRA)	A probable neutron star in CTB 80. 6, 20 and 90 cm.
AS-295	Simon, M. (Stony Brook) Vader, P. (Yale)	Radio mapping of the infrared loud quasar IRAS 00275-2859. 6 and 20 cm.
AS-298	Schwartz, P. (NRL)	Ionization associated with S140 IRS1. 2 and 20 cm.
AS-302	Steppe, H. (IRAM) Saikia, D. (NRAL) Salter, C. (IRAM) Cornwell, T.	Rotation measure, spectra and relativistic beaming. 2, 6, 18, and 20 cm.
AS-303	Saikia, D. (NRAL) Wiita, P. (Georgia State) Cornwell, T. Junor, W. (NRAL)	The nearby radio galaxy 1759+211. 6, 18 and 20 cm.
AS-304	Shara, M. (STScI) White, R. (STScI) Becker, R. (Calif., Davis)	Mapping the shell of the old nova CK Vul. 6 and 20 cm.
AS-305	Spangler, S. (Iowa) Cordes, J. (Cornell)	Strong interstellar scattering near the supernova remnant G33.6+0.1. 6, 20, and 90 cm.
AS-307	Sukumar, S. (Illinois) Allen, R. (Illinois)	Cosmic ray propagation in normal spiral galaxies. 90 cm.

No.	Observer(s)	Program
AS-308	Sukumar, S. (Illinois) Allen, R. (Illinois)	Spiral structure and star formation in normal galaxies. 90 cm.
AS-309	Sumi, D. (Illinois/Caltech) Norman, M. (Illinois) Smarr, L. (Illinois)	Survey of the radio structure of cooling inflow galaxies. 6 and 20 cm.
AT-60	Taylor, A. (NRAL) Seaquist, E. (Toronto) Kenyon, S. (SAO)	Radio-optical-UV monitoring of symbotic stars. 1.3, 2, 6 and 20 cm.
AT-86	Tarter, J. (Berkeley) Kardashev, N. (Space Res. Inst.) Slysh, V. (Space Res. Inst.)	Is the IRAS source G357.3-1.3 a Dyson sphere? 20 cm line.
AT-87	Torbett, M. (Kentucky) Campbell, B. (New Mexico)	Radio emission and morphology of variable stars. 2, 6 and 20 cm.
AT-88	Tereby, S. (Caltech) Vogel, S. (RPI) Myers, P. (SAO)	Water masers around low mass stars. 1.3 cm line.
AU-28	Ulvestad, J. (JPL) Antonucci, R. (STScI) Goodrich, R. (Santa Cruz)	Narrow-line Seyfert 1 galaxies. 6 and 20 cm.
AU-30	Ulvestad, J. (JPL) Antonucci, R. (STScI)	NGC 253. 6 and 20 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Radio supernova in NGC 4258. 6 and cm. 20 cm.
AV-145	Viallefond, F. Lequeux, J. (Marseille) Comte, G. (Marseille)	High density HI clumps in the blue compact galaxy IZw 18. 21 cm line.
AV-146	Viallefond, F. Heydari, (ESO, Chile)	HI observations in the low metallicity blue compact galaxy M6600. 20 cm line.
AV-148	Viallefond, F. Zheng, X. (CFA)	Low frequency survey of M33 radio sources, electron temperature of some HII regions, and large scale disk emission. 90 cm.

No.	Observer(s)	Program
AV-149	van Breugel, W. (Berkeley) Ebneter, K. (Berkeley) Miley, G. (STScI) Heckman, T. (Maryland) Baum, S. (Maryland) Muxlow, T. (NRAL)	Optical emission line source 3C 277.3. 90 cm.
AV-150	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Heckman, T. (Maryland) Miley, G. (STScI) Baum, S. (Maryland)	Extended line emission in powerful radio galaxies. 2, 6, 18, and and 20 cm.
AV-151	van Gorkom, J. Knapp, G. (Princeton) Ekers, R.	A search for atomic and molecular gas in elliptical radio galaxies. 20 cm line.
AV-152	van Buren, D. (Johns Hopkins) Miley, G. (STScI)	Search for high redshift molecules in absorption. 2, 6, and 20 cm line.
AW-169	Winglee, R. (Colorado) Dulk, G. (Colorado) McKean, M. (Colorado)	Search for bursts from nearby stars. 20 and 90 cm.
AW-173	Wilking, B. (Missouri) Mundy, L. (Caltech) Howe, J. (Texas)	Survey of cold IRAS sources. 2 and 6 cm.
AW-188	Wehrle, A. (UCLA) Morris, M. (UCLA)	The "figure-8" radio structure of NGC 2992. 2 cm.
AW-189	Walker, R. C. Benson, J.	Superluminal motion of 4 arcsec knot in 3C 120. 6 cm.
AW-191	Wootten, H. A.	Structure of the IRAS 16293 protostellar environment. 1.3 and 2 cm.
AZ-30	Zijlstra, A. Bignell, R. C.	Identification of a suspected radio galaxy. 20 cm.
AZ-31	Zhao, J. (New Mexico) Burns, J. (New Mexico) Owen, F.	Turbulent radio jets in cluster galaxies. 6 and 20 cm.
AZ-32	Zheng, X. (CFA) Reid, M. (Harvard) Birkinshaw, M. (Harvard) Ho, P. (Harvard)	The low frequency characteristics of NGC 6251. 90 cm.

No.	Observer(s)	Program
AZ-33	Zuckerman, B. (UCLA) Weintraub, D. (UCLA)	Circumstellar emission around T Tauri binary systems. 6 cm.

F. SCIENTIFIC HIGHLIGHTS

Mercury

The VLA was used to make the first centimeter interferometric observations that resolve the disk of the planet Mercury. At 6 cm wavelength the disk of the planet shows a non-uniform temperature distribution ranging from 300 K to 360 K. The only feature on the disk is a broad symmetric high temperature plateau slightly displaced from the center of the disk. Interpretation of the map is consistent with a model of blackbody re-radiation from preferential diurnal heating of the subsurface layers. No internal planetary heat source is required to model the observations. The confinement of polarized intensity to a narrow annulus around the limb of the planet is also consistent with the assumed dielectric properties of the surface and refraction in the atmosphere.

Investigators: J. O. Burns, M. Zeilik (UNM), G. R. Gisler, J. F. Borovsky, D. N. Baker (LANL)

CTB 80 SNR Contains a Pulsar

Using the Berkeley Fast Pulsar Search Machine, 300-ft observations have discovered a new milli-second pulsar in the supernova remnant CTB 80. The candidate was targeted for a period search after VLA maps of the SNR by R. Strom showed a compact, highly polarized, steep-spectrum radio source to be coincident with an unresolved X-ray source. The isolation of the pulsar and the determination of its properties came as a result of post-observation data analysis and the application of sophisticated period-finding algorithms at Berkeley. The pulsar period is 39.5 ± 5 msec, with a dispersion measure of 48 ± 3 pc cm^{-3} and flux density of about 10 mJy at 387 MHz. CTB 80 is only the third supernova remnant known to definitely have an associated pulsar after the Crab and Vela supernova remnants.

Investigators: T. R. Clifton, D. C. Backer, R.S. Foster (Berkeley), and S. R. Kulkarni (Caltech)

New Lensed Source?

High resolution VLA C and U band observations of a suspicious compact source have recently revealed a spectacular ring-shaped object which has all the characteristics of becoming the newest gravitational lens to be discovered. Several thousand snapshot images were originally obtained of sources from the 6 cm GB-MIT 300-ft telescope survey. The new object is one of the thousand snapshots to be rapidly processed by the Digital Productions Cray supercomputer in Los Angeles. Selected for high resolution detailed mapping on the basis of its snapshot image, the object's 2 cm image traces an almost perfect ellipse with two point sources located at opposite ends of the major axis. Its total diameter is only 0.8 seconds of arc. KNPO 4-m telescope CCD frames of the field show a very faint 22 magnitude image coincident with the source to the accuracy of current astrometry. Spectra show a red continuum devoid of any emission lines. Several potential gravitational lens models are being investigated to explain the unusual source morphology.

Investigator: J. Hewitt (Haystack Observatory)

New, Very Young Planetary Nebula?

VLA observations of OH/IR stars have resulted in the discovery of the most rapidly evolving and possibly youngest planetary nebula known. The object is the brightest planetary nebula in the radio sky, but there is no optical counterpart. The distance is probably less than 500 parsec. Associated with the nebula is a strong but rapidly weakening 1612 MHz OH maser line. This is very rare for planetary nebulae, and shows that this object is very young. From the rate of change of the OH maser, an expansion velocity of order $0''.1$ per year is predicted, 20 times larger than any other planetary nebula.

The object probably has only recently become a planetary nebula. Estimates are that the ionization started between 30 and 100 years ago. Most of the optical extinction could still be due to a dense, neutral envelope surrounding the nebula. The further evolution of this object will be an important test for models of the formation of planetary nebulae.

Investigators: A. Zijlstra (NRAO), S. R. Pottasch (Kapteyn Institute), and R. C. Bignell (NRAO)

G. PUBLICATIONS

Attached as Appendix A is a tabulation of all reprints 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

The Central Development Laboratory delivered four more front-ends (#20 through #23) to the VLA this quarter. One further front-end (#24) is awaiting shipment and two more are close to completion. We have all the parts on hand for the final receivers and hope to complete the last one (#30) by the end of 1987.

The currently manufactured receivers use GE HEMT's and have a typical $T_R \leq$ 13 K.

L-Band Cooled HEMT Amplifier Development

A total of 15 existing L-band GaAsFET amplifiers have been retrofitted with HEMT's. Of these, two have been installed in the 1.3-1.8 GHz receiver in Green Bank and two in a VLBA L-band receiver. The rest are being used in Tucson and Charlottesville as IF amplifiers for SIS mixers and cooled Schottky mixers.

The demand for the retrofit of more of the existing GaAsFET L-band amplifiers with HEMT's is high, and we plan to spend a few months at the beginning of 1988 doing this. At the same time, we will build new L-band HEMT amplifiers for the remaining VLBA receivers.

23 GHz Cooled HEMT Amplifier Development

During this quarter a further 8 K-band amplifiers have been built for the VLA. Four of these amplifiers use Fujitsu 0.5 μ devices and have a T_{AV} of $\approx$ 70 K. Two amplifiers using Fujitsu 0.25 devices give similar performance to the amplifiers with 0.50 μ devices. The remaining two amplifiers use GE HEMT's and give a T_{AV} of $\approx$ 55 K. The performance of these devices is clearly superior to that of the Fujitsu 0.25 μ and 0.5 μ devices. However, these devices are obtained sporadically from GE for evaluation by NRAO. Partial support of this program at GE comes from JPL.

43 GHz Cooled HEMT Amplifier Development

The goal of this work is a cryogenically-cooled, 4- to 6-stage amplifier giving ~ 30 dB gain and 60 K noise temperature in the 42 to 44 GHz range. The key requirement is for a HEMT device which can meet these requirements. Small-width, very high frequency devices received from GE earlier this year had unusually poor cryogenic performance as exhibited by DC characteristics. A new batch is expected near the end of 1987.

During this quarter work has been performed in the following areas:

a) Procurement and test of components for an amplifier test set.

b) Further tests and analysis of a prototype chip test fixture operating at 23 GHz.

c) Design and procurement of quartz substrates for a prototype 43 GHz amplifier.

d) Fabrication of a scale model of the microstrip-to-waveguide transition required by the amplifier.

During the next quarter a room temperature, one-stage amplifier should be assembled and tests with new HEMT devices should begin.

Hybrid Spectrometer

Work on the full-scale version of the digital section of the 1536 channel and 2.4 GHz bandwidth hybrid correlator continues. The sampler bins are completed and testing of the fully integrated system will start in October. Delivery to Tucson is expected before the end of 1987.

Superconducting (SIS) Millimeter-Wave Mixer Development

We have recently installed new SIS mixers and HEMT IF amplifiers in the 90-116 GHz receiver on the 12-m Kitt Peak telescope. The receiver can be tuned for true SSB operation with 20 dB image rejection or for broadband (DSB) operation. In the SSB mode, receiver noise temperatures vary from 55 K SSB at 90 GHz to 83 K SSB at 115 GHz in the better channel and are about 20 K higher in the other channel. In the DSB mode, receiver noise temperatures are between 47 K and 55 K DSB in the better channel. These numbers include all input optics losses (beam-splitter, lens, and vacuum window). The new mixers use Nb/Pb-In-Au edge-junctions designed by NRAO and fabricated by IBM. These have tuning circuits integrated with the junctions. The replacement of the old GaAsFET IF amplifiers with HEMT amplifiers (see L-Band HEMT amplifier section above) improved the receiver noise temperature by about 35 K.

We have completed DC tests on the first developmental junctions made under a joint project with UVA. These are Nb/Al-Al_2O_3/Nb devices and have extremely sharp I-V curves--essential for good SIS mixers. Based on recent tests, it should be possible to heat these to 150°C for prolonged periods (e.g., for bonding), and even to 200°C for a few minutes. Storage at room temperature in the open atmosphere causes no degradation. The present mask set contains mixers for 90-120 GHz and 230 GHz, as well as special circuits for characterizing the material.

Schottky Diode, Millimeter-Wave Mixer Development

Seventeen 200-240 GHz mixers have been fabricated for the eight-beam 230 GHz receiver on the 12-m telescope, for the old dual-polarization receiver, and for four 225 GHz site testing receivers (see below). Mixer noise temperatures are from 430 K to 830 K SSB. This extremely wide range appears to be a result of differences between diode chips, and even between different diodes on the same chip. Although some of the new 2I1 diodes from UVA have given mixer noise temperatures around 500 K, the best results are still obtained with the no longer available UVA 2P9 diodes.

We are just starting tests on a new 280-310 GHz Schottky mixer design. Initial indications are that it will have a receiver noise temperature ~1000 K SSB, about a factor of two better than the previous receiver for this band.

Site Testing Receivers

Four compact, room-temperature, 225 GHz radiometers for site evaluation have been completed. These will be located at the VLA, Mt. Baldy, Mauna Kea, and Kitt

Peak to aid in selecting a site for the future millimeter-wave array. These radiometers have a DSB noise temperature of ~ 1500 K and operate unattended at remote sites.

300-foot Spectral Processor

The Spectral Processor project continues in the design phase. The custom wire-wrap boards for the FFT board have arrived. A single copy will be constructed and tested on these boards before beginning replication. The accumulator board design is still under way. With the exception of the multiplier board, all other digital boards have been prototyped. The rack controller computer and interface cards have been ordered and design of the rack configuration has begun.

Two 160 MHz fixed LO synthesizers were constructed for the IF/Video converters. An automated test-set was started, and partially completed, to assist with the construction of the SSB converters.

140-foot Cassegrain System

As the culmination of over a year's worth of work in developing a holographic surface-mapping system for the 140-foot, the telescope surface panels were adjusted this quarter. Maps made from the prime-focus before and after the adjustments showed that the rms accuracy of the main reflector went from 0.95 mm to 0.60 mm. The deformable subreflector was measured mechanically and adjusted, reducing its rms deviations from 0.40 mm to 0.29 mm. Cassegrain holography maps made after the surface adjustments indicates a total rms accuracy for the main reflector plus subreflector of 0.80 mm. Aperture efficiency near zero declination and hour angle increased from a value of 20 percent to about 27 percent at 25 GHz.

One of the Cassegrain maser receivers was removed to investigate a problem manifested as a reduced tuning range. The investigation is continuing, but it appears that the field strength of the circulator magnets has changed. It is expected that the system will be repaired and installed during October.

Adaptive Array Receiver

The Adaptive Array Receiver project continues in the design phase. Eleven of the sixteen amplifiers have been completed, and enclosures and components needed for the sixteen voltage controlled phase shifters have arrived. Measurements on a prototype cavity-backed dipole feed showed a beam that is much too broad. We are investigating alternate feed designs that will provide the required illumination pattern and will allow the necessary feed-to-feed spacing.

J. 12-M ELECTRONICS

Receiver Status

The status of the various receivers is largely unchanged since the last quaterly report.

70-115 GHz Schottky Mixer Receiver

This two-channel receiver is unchanged since the last quarterly report. It is the only receiver to cover the frequency range 70-90 GHz and is used as a back-up to the SIS receiver in the 90-115 GHz band. This receiver is also used for continuum observations at 90 GHz.

200-270 GHz Schottky Mixer Receiver

This receiver is being modified at the present time. Our objective is to be able to provide two channel operation over the frequency bands 200-270 GHz, 270-305 GHz, and 330-360 GHz.

90-115 GHz SIS Receiver

This receiver is now in routine use, and noise temperatures in both channels of around 100 K SSB are obtained across the frequency range.

Multifeed 230 GHz Receiver

The four-feed prototype was tested on the telescope earlier in the year and performed well. No problems were found and work has continued on completing the eight beam receiver. A beam rotating mechanism has been fabricated and tested and the receiver should be completed before the end of the year.

Hybrid Spectrometer

Manpower and money shortages have delayed the completion of this project. We are now hoping for initial telescope tests in spring of 1988.

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.

When the VLA antennas are heated by the sun at 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 arcminutes. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Twenty-eight antennas currently have insulation installed and this part of the antenna pointing program is complete.

Another, lesser, pointing problem which will be addressed in the future is the occurrence of tilts of up to 20 arcseconds in the azimuth axis of a few antennas at certain azimuth angles. This effect is presumably caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Some preliminary tests have been completed. Testing of the stability of two tilt-meter units is continuing during this quarter.

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.

VLA 300 MHz Receiver

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

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

Twenty antennas now have 327 MHz receivers installed, and this system is undergoing test and evaluation. The final feed configurations have been determined. To reduce local RFI, RFI enclosures for the vertex mounted "B" racks have been installed on four antennas (see RFI Improvements). No funding has been provided for continuation of this project and material procured last year has been assembled. After the installation of the next two systems, completion of this project will be delayed pending further funding for this project.

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 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 GaAsFET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers have been incorporated into these systems during this quarter.

Twenty-three 8.4 GHz front-ends have been received from the Central Development Laboratory in Charlottesville and have been installed on fourteen antennas. Interferometer and phased-up sum measurements with these antennas on Voyager 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 remaining fourteen X-band systems will continue through 1988.

RFI Improvements

The sensitivity of the 327 MHz and 75 MHz systems will be limited partly be radio-frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous useable bandwidth was investigated. A modification to allow the monitor and control system to free run eliminated the coherent RFI between antennas.

Four RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosure will be installed during the first part of the next quarter, eliminating the remaining locally 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 this 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).

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 5-6 means a tremendous boost in speed and sensitivity. Experiments will be 20-30 times faster. Eight-hour experiments will then take only a little over 30 minutes. Instead of one region per u-v track, 20-30 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 GaAsFET 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 GaAsFET being developed in the GB Electronics Division will be used to replace present 5 GHz paramps. The new "A" rack has been installed on nine antennas.

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 and 50 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 GaAsFET amplifiers as those used on the VLA, 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 a separate, optimized receiver. 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 GB 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 first quarter of the year.

L. AIPS

During this quarter two major software projects were released for general use. In one, the new task PCAL determines the polarizations of the antennas and the calibration sources. The other tasks within AIPS were revised to display and apply the polarization calibrations determined with PCAL. In the other, the new task TVFLG displays interferometer data on image (TV) devices and prepares editing commands through interaction with the user. Two other major projects, bandpass calibration and a restructuring of the machine-dependent code, remained under development.

The routines which handle source models for imaging and calibration were made more general. The individual components of the models may now be extended gaussians or optically thin uniform spheres as well as points. Several bugs which were particularly detrimental to VLBI calibration were corrected prior to the July 15, 1987 release of AIPS. During the quarter, numerous other improvements and corrections were made, particularly in the area of calibration and magnetic tape tasks.

M. VLA COMPUTER DIVISION

Work on the new on-line system is progressing well. It is hoped that we can still meet the deadline of controlling the array by the end of October. The old on-line system will be removed from operation at this time and will be completely de-installed at the end of the year. This requires that the VLA will be out of operation between Christmas 1987 and January 11, 1988. The interactive displays that are used by the operators and the electronics group to monitor the performance of the array have been provided to the operations group for testing. Several suggested alterations have already been incorporated.

The modifications to the image storage unit (ISU) attached to the Outbax computer were successfully completed. The new control panel provides more flexible control. A second unit will also be fabricated for use on the display attached to the Convex computer at the VLA. At this time the capacity will be increased by more than 50 percent by the addition of higher capacity disk drives.

The new digital data switch (DDS) for the Socorro office is complete. This DDS is connected via the dedicated phone lines to the other DDS units at the VLA site and in Charlottesville. This new capability allows every user with a terminal or personal computer at any one of these sites to communicate directly with the mainframe computers at any site.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The Pie Town antenna erection was completed during the past quarter, except for certain acceptance tests. The outfitting of this site was completed to the extent of delivered systems. First signals were observed with the antenna in early September, using a prime focus feed at 327 and 610 MHz.

In July an on site inspection was made at Milliflect, the subreflector subcontractor, to verify the accuracy of their master "male" mold for the reflecting surface. Major deviations from specified tolerances were found. It developed that the problem was their method of measurement for this asymmetric surface. It was so time consuming for the many points to be checked that closure to a final "figure" of the surface was practically unfeasible. Changing to a more efficient measurement technique markedly relieved the problem. A follow-up visit at the end of September verified that except for a few minor corrections the master mold meets tolerance, and should shortly be ready for use to make the working mold for manufacturing to begin. The first subreflector is now scheduled to be shipped in mid-December to the University of Arizona for surface verification on their Large Optical Generator. If found satisfactory, this subreflector is planned for installation on the Pie Town antenna in January, on the modified focus rotation mount #2 described below.

Some significant design and manufacturing problems were found in the focus rotation mount, which is subcontracted to IMC Corporation. Examples are inadequate weather seals for the rotation bearing; a second motor drive screw needed to avoid focus motion binding; and strengthening of the moving center ring casting to limit warping, and to survive a full torque focus motor limit override. Progress in solving these problems has been made, with trial changes being made at the VLA to FRM #2, prior to its scheduled January, Pie Town installation. After environmental and endurance cycle testing of this modified mount during the next few months (e.g., verifying low temperature operation), formal design change orders will be effected. Time for manufacture and final tests of production mounts manufactured to the new specifications are being evaluated by IMC, but may cause a delay for full operation of the Kitt Peak site. To our best knowledge, such a delay would not effect other aspects of VLBA system development, debugging, or schedule.

At Kitt Peak (#2) the site work is complete, and the antenna erection is virtually complete. Outfitting by NRAO personnel is scheduled to begin in late October. At Los Alamos (#3) the site and foundation are complete and antenna erection is approximately one-third complete.

The site, foundation, and building at Fort Davis (#4) is under construction and 85 percent complete. Unsubstantiated billing by the general contractor for this site led to an investigation by our subcontract administrator. Information obtained led to NRAO declaring this contractor in default of contract on September 15. Their attorney stated that they filed Federal Chapter 7 bankruptcy shortly thereafter. Contractor performance was fully surety bonded. With the bonding company's cooperation, there was no pause in work by the primary remaining subcontractor (mechanical and electrical). The site is expected to be ready, as prior to these events, for the RS antenna erection crew in December. [Note: Due to the antenna erection schedule which requires a winter erection of this number 4 antenna, RS requested, and was granted, a switch in the North

Liberty/Fort Davis erection order. Fort Davis becomes the fourth site and North Liberty the fifth.]

At North Liberty, IA (#5) the site, foundation, and building are under construction, and are well ahead of the scheduled "need date." The same status applies to the Brewster, WA (#6) site.

During the next quarter, completion of lease negotiations are expected for two of the remaining four sites: St. Croix, VI (#7); Owens Valley, CA (#8). Evaluation and selection of the desired Hawaii (#9) site (on Mauna Kea) were completed in September. The RFI survey of possible Northeast (#10) sites will be completed in early October.

Electronics

A comprehensive series of system tests were satisfactorily concluded at the VLA in July on the first two sets of VLBA receiver electronics, including tests of relative phase stability when the temperature of one of the assemblies was varied substantially.

The initial set of electronics will remain at the VLA to serve as a test vehicle for module maintenance and repair, while the first field set, comprising three racks, all cables, and front ends for 330/610 MHz, 4.8 and 10.7 GHz, has now been installed at the Pie Town station. Front-ends for 1.5, 2.3, 8.4 and 23 GHz will be added next quarter. Tests of the first 23 GHz unit showed that this front end design will require a change in first intermediate frequency to avoid a spurious response.

Test range patterns of the first 1.5 GHz feed horn have proved satisfactory, and it will be installed at Pie Town at the same time as the subreflector.

In early September, the set of electronics for Kitt Peak was shipped to the VLA for a checkout with the monitor/control computer. Rack assemblies for the Los Alamos set are complete, and modules are well along. It is tentatively planned to forego pre-installation tests at the VLA for this and subsequent sets of electronics.

Hydrogen masers #1 and #2 were received at the VLA in September. Initial tests indicate satisfactory oscillation, but stability of the frequency multipliers is still under study. Maser #3 is complete at Sigma Tau, and #4 is being brought into initial operation. One of the masers will shortly undergo tests at JPL's new facility.

Data Recording

The first data acquisition rack (DAR1), without formatter, has been moved to Pie Town, following system tests at the VLA with receiver electronics and monitor/control equipment. At Haystack, DAR2 (again without formatter) is complete, and the first formatter has now been finished and checked out. Assembly of the first recorder (REC1) was completed, and system integration tests together with DAR2 and the first formatter are well along. Initial data recording and playback tests have been successfully carried out under the control of the VME computer.

Recorder performance appears superior to that of the earlier MkIIIA recorders, both in the more precise control of tape position afforded by the new controller and the cleaner analog signals which result from better shielding. Actual fringe tests are planned using the Haystack and Westford (60-ft) telescopes (VLBI) prior to October 9, when DAR2, the first formatter and REC1 are scheduled to be shipped to the VLA.

No funds are budgeted for an initial supply of VLBA tape until 1989, the plan being to support initial Network VLBI operations of the first several VLBA stations from the pool presently in use by the US VLBI Network. With these existing tapes, reels will have to be changed every 3-4 hours, as opposed to every 12 hours with the larger reels, and improved tapes planned for ultimate use. Investigations continue as to the best sources for suitable tape and the special glass reels required for smooth operation.

Procurement of long-lead items has begun toward the construction of DAR3, DAR4 and REC3, under the pre-production phase (Phase III) of the Haystack subcontract (AUI-216). This phase, to be largely completed during 1988, will also provide the required final drawings, parts lists, and final cost estimates required for production in quantity. Phase III will also cover Haystack's construction and test of the first tape playback drive (PBD, formerly called PYB).

Following a recent overall review of the proposed data playback system, it was decided to incorporate most of that System's digital signal processing functions into the correlator, thus eliminating the so-called data playback crate (DPC). The correlator group has thus undertaken a major redesign of the correlator input interface, which will now be referred to as the playback interface (PBI), to reflect more accurately the new arrangement. The PBI design effort thus far is reported in the correlator section below.

It has been decided that after Phase III of the subcontract NRAO will also assume overall responsibility for the DAR's, which contain the baseband conversion, sampling,and formatting electronics. Detailed plans are incomplete, but it is presently proposed that NRAO produce the racks and some portion of the modules, subcontracting the remaining modules to Haystack. Construction of two such racks will be started at Charlottesville by mid-1988.

It is planned that production of the REC's and PBD's will remain with Haystack under future phases of the NEROC subcontract.

Monitoring and Control

The Pie Town station computer has been used for control of the antenna, the receiver switching, and the data acquisition rack modules, in both technician/diagnostic mode and in actual observing mode. Work is progressing on making the system more nearly error-free and more capable. The MicroVax which will eventually serve as the array control computer is now being used for software development of some of the programs which will be used to exchange information between the MicroVax and the Motorola station computers. Final development of an integrated control system is awaiting the delivery of a co-processor from Motorola which will handle the X.25 network protocol. This is expected late in the fourth quarter of 1987 or early first quarter of 1988.

Control and diagnostic functions for the hardware yet to be delivered, principally the formatter and tape transports, will be intensively under development in the last quarter of 1987.

We expect to be able to support limited observations at Pie Town late in 1987, such as the NUG 327 MHz run on November 18.

Correlator

Design of the multi-purpose gate array, the "FX chip," has now progressed as far as is possible before committing significant funding. Based on this work, a detailed preliminary specification was formulated during this quarter, and expressions of interest solicited from potential vendors. To date, two vendors have been identified who appear to offer a product suitable for this critical element of the correlator.

Specification of the correlator's major functional elements also advanced sufficiently that layout work could begin on the FFT and multiplier/accumulator modules which will make up the bulk of the correlator proper. It is anticipated that the complete 20-station, 8-channel VLBA system will occupy only four standard racks, plus one or two racks for associated computer equipment. The planned correlator structure will allow future expansion to support more station input ports, and/or more IF channels.

As stated earlier, responsibility for the data playback crate (DPC) portion of the data playback system was assumed early this quarter by the correlator group as a major new task. As design began, it became evident that substantial simplification could be achieved by merging the required de-skewing, resynchronization, frame buffering, demultiplexing, and editing functions of the DPC into the correlator's delay tracking module. This amounts to a thorough redefinition of the data-playback/correlator interface, and the new, more complex module will now be called the playback interface, or PBI. It will receive individual digital data and clock signals recovered from each of 36 data-playback tracks, and will transmit commands modifying the playback speed to achieve and maintain data synchronization. It seems clear that the above approach will result in savings both in space and funds. However, the impact of this design augmentation on the overall correlator schedule has not yet been established.

Also during this quarter, requirements and possible schemes were studied for switching the 24 data playback drives among the correlator's 20 input station ports to support both efficient routine tape changing and actual spare applications. Ongoing development of delay and phase tracking algorithms continued.

A Motorola 68020-based, VME-bus microcomputer system was ordered for use in developing several of the applications which will eventually reside in processors of this type within the correlator. These applications include the archive writer, fringe fitter, archive-to-distribution translator, and system-control functions.

Data Processing

Most of the software needed for normal processing of astronomical data from the VLBA is already in routine production use. Development continues in three general areas: 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).

1) The preliminary version of the distribution tape has been designed. Software has been written to convert data from the NRAO MkII VLBI correlator into the form of the proposed VLBA distribution tape. This software is operational and is used to read data for developing item 2).

2) The preliminary design of the calibration software is done and being implemented. The continuum calibration routines are in production use. Development continues in the areas of polarization, spectral line calibration and interactive editing of data.

3) The concerns of geometric accountability are being included in the design of all software and data structures. Examination of existing geodetic software is continuing to see if it can be adapted for NRAO uses.

Array Operations Center

Construction was initiated in August 1987 for the AOC building by the firm of Bradbury & Stamm under a contract issued by the NMIMT. Occupancy is scheduled for August 1988, and detailed planning for the move is underway.

O. PERSONNEL

New Hires

Desmond, James	Associate Director, Administration	07/01
Stetten, Kenneth	Assistant to VLBA Project Manager	07/06
Garagnon, Bruno	Scientific Programming Analyst	07/20
Krishnan, S.	Visiting Electronics Engineer II	08/27
Bastian, Timothy	Research Associate	09/01
Petencin, Gerald	Electronics Engineer II	09/21

Terminations

Morgan, Lorraine	Scientific Programming Analyst	07/02
Wadiak, James	Research Associate	07/08
Riffe, Theodore	Associate Director, Administration	07/31
Fleck, Robert	Visiting Scientist	07/31
Liu, Zhong-Yi	Visiting Research Associate	08/18
O'Dea, Christopher	Research Associate	08/18
Barvainis, Richard	Research Associate	08/31
Bradley, Richard	Electronics Engineer II	08/31
Kashlinsky, Alexander	Visiting Research Associate	08/31
Killeen, Neil	Research Associate	08/31
Simonetti, John	Research Associate	08/31

Change in Status

Napier, Leroy	to Scientific Programmer	07/01
Thompson, Richard	to Deputy VLBA Project Manager	07/01
Romney, Jonathan	to Head, VLBA Correlation Division/ Systems Scientist	08/01

Other

Van Gorkom, Jacqueline	Leave of Absence
Rots, Arnold	Leave of Absence
Weinreb, Sander	Leave of Absence

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