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NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

July 1, 1988 - September 30, 1988

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A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	2018.00	1990.50	479.75	1,672.9
Scheduled maintenance and equipment changes	144.50	217.50	14.75	277.0
Scheduled tests and calibrations	45.50	0.00	1,713.50	264.2
Time lost	75.00	74.25	28.75	163.3
Actual Observing	1943.00	1916.25	451.00	1,509.6

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Programs
F-97	Fich, M. (Waterloo) Silkey, M. (Washington)	Measurements at 10 cm of the temperatures of distant galactic HII regions.

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
A-88	Anantharamaiah, K. Radhakrishnan, V. (Raman) Shukre, C. (Raman)	Observations at 6 cm to confirm a possible detection of positronium.
A-89	Anantharamaiah, K. Vivekanard, M. (IRAM) Morris, D. (IRAM) Downes, D. (IRAM) Radhakrishnan, V. (Raman)	Search at 3.5 cm for fine structure lines of positronium.
B-493	Bania, T. (Boston) Rood, R. (Virginia) Wilson, T. (MPIR, Bonn)	Measurements at 8.666 GHz of $^3He^+$ emission in HII regions and planetary nebulae.

No.	Observer(s)	Programs
C-248	Crutcher, R. (Illinois) Goodman, A. (CFA) Heiles, C. (Berkeley) Kazes, I. (Meudon) Myers, P. (CFA) Troland, T. (Kentucky)	Zeeman observations of OH at 1665 and 1667 MHz.
L-220	Lubowich, D. (Hofstra) Turner, B. Hobbs, L. (Yerkes)	Search at 803.5 MHz for ^{7}Li (lithium) in the Galactic Center.
M-281	Magnani, L. (Arecibo)	CH observations at 9 cm of IRAS infrared clouds.
M-282	Magnani, L. (Arecibo) Lada, E. (Texas) Sandell, G. (Manchester)	Observations at 9 cm of CH emission from the molecular outflows of pre-main sequence stars.
M-283	Likkel, L. (UCLA) Morris, M. (UCLA) Maddalena, R.	Monitor at 1.3 cm unusual H_2O emission from two IRAS sources.
M-284	Brown, R. (Monash Univ.) Godfrey, P. (Monash Univ.) Henkel, C. (MPIR, Bonn) Irvine, W. (Massachusetts) Madden, S. (Massachusetts) Wilson, T. (MPIR, Bonn) Maddalena, R.	Time variability study at 1.5 cm of ammonia masers.
T-217	Kazes, I. (Meudon) Turner, B.	Search at 9 cm for CH in OH megamaser galaxies.
T-248	Turner, B.	Search for hyperfine CH lines at 702 and 724 MHz.
W-236	Loren, R. (Texas) Wootten, H. A.	Mapping at 14.4885 GHz of two newly discovered regions of H_2CO emission in Rho Oph cloud cores.
W-258	Mangum, J. (Virginia) Wootten, H. A.	Search at 14.7 GHz for c-C_3H in the interstellar medium.
Y-3	Yusef-Zadeh, F. (NASA) Anantharamaiah, K.	Search at discrete frequencies between 4.7 and 7.2 GHz for recombination lines from the Galactic Center region.

No.	Observer(s)	Programs
Y-7	Yusef-Zadeh, F. (NASA) Maddalena, R.	Search at 22.235 GHz for water vapor masers in selected regions of the Galactic Center.
Z70	Zuckerman, B. (UCLA) Maddalena, R.	Search at 18 cm for OH maser emission toward carbon stars.

The following pulsar program was conducted during this quarter.

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

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

B - Effelsburg, MPIR 1000 m	Mb - Itapetinga 20 m
F - Fort Davis 85 ft	N - NRL Maryland Pt. 85 ft
Fb - Fairbanks, Alaska 25 m	O - Owens Valley 130 ft
G - Green Bank 140 ft	Pt - Pietown 25 m
H - Hat Creek 85 ft	R - Crimea USSR 30 m
Jb - Jodrell Bank MK II 25 m	Sa - Shanghai 25 m
Km - Haystack 120 ft	Sn - Onsala 20 m
Lm - Medicina 32 m	Yn - Socorro n=1-27x25 m
M - Nobeyama 45 m	Z - Torun 15 m

Only the name of the principal observer is shown.

No.	Observer(s)	Programs
A-22V	Alef, W. (MPIR, Bonn)	Monitor at 2.8 cm of 3C 48 with telescopes B, F, G, H, Km, Lm, M, O, Pt, R, and Sa.
A-H39V	Witzel, A. (MPIR, Bonn)	Fringe tests at 1.3 cm for phase referencing with telescopes B, G, J, Km, Lm, N, O, Sn, and Yn.
AH-41V	Hewitt, J. (Haystack)	Attempt at 3.6 cm to detect a gravitational lens source with telescopes B, G, and K.
B-91V	Bartel, N. (CFA)	Observations at 3.6 cm of a supernova image with telescopes B, G, Km, O, Sn, and Yn.

No.	Observer(s)	Programs
C-48V	Claussen, M. (NRL)	Protostellar kinematics measurements at 1.3 cm with telescopes G, Km, O, and Yn.
G-59V	Greenhill, L. (CFA)	Measurements at 1.3 cm of the distance of M33 with telescopes B, J, Km, M, O, and Yn.
H-41V	Hooimeyer, J. (Leiden)	Monitor at 2.8 cm of 1721+343 with telescopes B, F, G, H, Km, Lm, and O.
H-45V	Hough, D. (JPL)	Measurements at 2.8 cm of the core of 3C 334 with telescopes B, F, G, Km, and O.
L-55V	Lawrence, C. (Caltech)	Survey at 1.3 cm of selected sources with telescopes B, G, Km, Lm, O, Pt, Sn, and Yn.
M-93V	Marr, J. (Berkeley)	Studies at 1.3 cm of NGC 1275 with telescopes B, G, J, Km, Lm, N, O, Sn, and Yn.
M-97V	Marcaide, J. (Astrofisica, Spain)	Studies at 1.3 and 2.8 cm of 4C 39.2 5with telescopes B, F, G, H, Km, Lm, O, Pt, and Z.
N-15V	Neff, S. (NASA)	Pilot survey at 1.3 cm of NGC 1068 with telescopes B, G, Km, O, and Yn.
N-17V	Niell, A. (Haystack)	Observations at 3.6 cm of AE Aquari with telescopes B, G, Dm, and Yn.
P-82V	Pauliny-Toth, I. (MPIR, Bonn)	Monitor at 2.8 cm of 2134+004 with telescopes B, F, G, Hm, K, Lm, O, and S.
P-83V	Pauliny-Toth, I. (MPIR, Bonn)	Monitor at 2.8 cm of 3C 454.3 with telescopes B, F, G, H, Km, Lm, Mb, and O.
P-87V	Porcas, R. (MPIR, Bonn)	Observations at 3.6 cm of 0831+557 with telescopes B, F, G, H, K, L, O, Pt, Sn, and Yn.
S-78V	Shaffer, D. (Interferometrics)	Astrometry at 3.6 cm of CTD93 with telescopes F, Fb, G, H, Km, N, O, and Pt.
W-45V	Witzel, A. (MPIR, Bonn)	Monitoring at 1.3 cm of 1928+738 with telescopes B, G, J, Km, Lm, N, O, Sn, and Yn.

No.	Observer(s)	Programs
Z-12V	Zensus, A. (Caltech)	Measurements at 2.8 cm of 0821+62 with telescopes B, G, Km, and O.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Programs
A-082	Aller, H. (Michigan) Aller, M. (Michigan) Payne, H. (STScI)	Observations at 880, 1400, and 2700 MHz of low frequency variable sources.
B-506	O'Dea, C. (NFRA) Balonek, T. (Colgate) Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)	Polarization and flux density measurements of variable sources at 2695 MHz.
B-507	Burke, B. (MIT) Conner, S. (MIT) Heflin, M. (MIT) Lehar, J. (MIT) Griffith, R. (MIT)	Observations at 5 GHz to extend the MIT-Green Bank Survey from $\delta = +37°$ to $+51°$.

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
H-242	Haynes, M. (Cornell) Herter, T. (Cornell)	Hydrogen observations of SO galaxies in the local supercluster.
H-243	Haynes, M. (Cornell) Giovanelli, R. (Arecibo) da Costa, L. (CNPq, Brazil) Mathewson, D. (Mt. Stromlo) Ford, V. (Mt. Stromlo) Barton, A. (Princeton) Benensohn, J. (Cornell) Schuster, P. (Cornell)	Hydrogen observations of Sc galaxies to measure deviations from the Hubble expansion.
K-313	Kerr, F. (Maryland) Henning, P. (Maryland)	Further search for galaxies in the Zone of Avoidance by the study of HI.

No.	Observer(s)	Programs
L-231	Lockman, F. J. Bregman, J. McNamara, B. (Virginia) Roberts, M. Blitz, L. (Maryland) Gir, B. (Maryland) Rho, J. (Maryland)	Observations of galactic HI toward supershells; observations of HI in other galaxies that are strong X-ray sources.
P-143	Petuchowski, S. (NASA) Bennett, C. (NASA)	Search for highly redshifted OH at discrete frequencies between 500 and 1000 MHz.
T-224	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations at 21 cm of quantization and time variability in galaxy redshifts.

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

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

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
D-162	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
G-297	Grabelsky, D. (Northwestern) Ulmer, M. (Northwestern)	Search For CO (J=2-1) emission from cD galaxies at the centers of cooling flows.
G-305	Garden, R. (Calif., Irvine) Russell, A. (JAC, Hawaii) Neufeld, D. (Berkeley)	A search for shock-ionized gas in high-velocity molecular flows.
H-252	Hollis, J. M. (NASA) Jewell, P. Lovas, F. (NBS)	Search for CH_2 in Orion A.
L-224	Lewis, B. M. (Arecibo)	Study to explore similarities of DGE stars with/without 1612 MHz masers at 86 GHz SiO.

No.	Observer(s)	Programs
M-279	McCutcheon, W. (CSIRO) Dewdney, P. (DRAO) Purton, C. (DRAO) Hutter, J. (British Columbia)	CO observations of sources selected from the IRAS Point Source Catalog.
S-318	Schombert, J. (Caltech) Bothun, G. (Michigan) Mundy, L. (Caltech)	Study of CO emission in low surface brightness galaxies.
S-320	Stacey, G. (Berkeley) Townes, C. (Berkeley) Lugten, J. (Hawaii) Genzel, R. (MPIR, Bonn)	Study of (J=1-0) CO in NGC 3079.
W-242	Wilson, C. (Caltech) Scoville, N. (Caltech)	Detailed star formation studies in M33 and M101.
W-256	Walker, C. E. (Arizona) Carlstrom, J. (Berkeley) Martin, R. (Arizona)A fully sampled (half-beam spacing) CO (J=1-0) study of IR bright galaxies.	

E. VLA OBSERVING PROGRAMS

No.	Observer(s)	Program
AA-85	Alexander, P. (MRAO) Pooley, G. (MRAO) Sopp, H. (MRAO) Wynn-Williams, C. (Hawaii) Green, D. (DRAO)	Dynamics of atomic and molecular gas in interacting galaxies. 20 cm line.
AA-87	Appleton, P. (Lancashire Polytech) van Gorkom, J. (Columbia) Ghigo, F. (Minnesota) Struck-Marcell, C. (Iowa State)	A giant intergalactic HI bubble near Arp 143. 20 cm line.
AA-88	Anantharamaiah, K.	Anamolous motions of HI clouds. 20 cm line.
AA-89	Anantharamaiah, K. Bagri, D.	OD at 8 GHz. 3 cm line.
AA-90	Anglada, G. (Barcelona) Lopez, R. (Barcelona) Estalella, R. (Barcelona) Rodriguez, L. (CFA)	Variable radio source associated with IRAS 16293-2422. 2 cm.

No.	Observer(s)	Programs
AA-91	Appleton, P. (Iowa State) Joseph, R. (Imperial College)	Testing the triggering mechanism of starburst galaxies: mapping the HI in infrared active/inactive pairs. 20 cm line.
AA-92	Appleton, P. (Iowa State) Schombert, J. (Caltech) Hughes, D. (Lancashire Polytech)	HI plume associated with NGC 3628 in the Leo triplet of galaxies. 20 cm line.
AA-93	Alexander, P. (MRAO) Sopp, H. (MRAO) Pooley, G. (MRAO)	Systematic study of active nuclei in star forming galaxies. 6 and 20 cm.
AA-94	Allen, R. (Illinois) Sukumar, S. (Illinois)	Linearly polarized radio emission from NGC 891. 6 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio flux of HD 193793 and P Cygni. 2 and 6 cm.
AB-470	Bosma, A. (Marseille) Athanassoula, E. (Marseille)	A survey of warped and flaring HI disks. 20 cm line.
AB-485	Brosch, N. (Wise Observatory) Gondhalekar, P. (Rutherford/ Appleton)	Late-type dwarf galaxies in the Virgo cluster. 6 and 20 cm line.
AB-491	Beck, R. (MPIR, Bonn) Hummel, E. (NRAL) Loiseau, N. (MPIR, Bonn) Berkhuijsen, E. (MPIR, Bonn)	The magnetic field in M31. 20 cm.
AB-493	Bregman, J. van Gorkom, J.	HI imaging of the cooling flow elliptical NGC 4406. 21 cm line.
AB-495	Bastian, T. Cornwell, T. Dulk, G. (Colorado)	Temporal evolution of solar active regions. 6 and 20 cm.
AB-498	Braun, R. Hester, J. (Caltech) Cox, D. (Wisconsin) Raymond, J. (CFA)	Direct measurement of magnetic field strength and relativistic ion fractions in SNR's. 4 cm.
AB-499	Bothun, G. (Michigan) van Gorkom, J. Bagri, D. Impey, C. (Steward Obs.)	HI imaging of the low surface brightness galaxy Malin 1. 20 cm line.

No.	Observer(s)	Program
AB-502	Baum, S. (NFRA) Bridle, A. Heckman, T.(Maryland) Miley, G. (STScI) van Breugel, W. (Berkeley)	Large scale structure of 3C 98. 6 cm.
AB-503	Briggs, F. (Pittsburgh) Garwood, R. (Pittsburgh)	The disturbed HI of NGC 772. 20 cm line.
AB-505	Beck, R. (MPIR, Bonn) Klein, U. (MPIR, Bonn)	The magnetic field in M51. 18 and 20 cm.
AB-506	Bally, J. (Bell Labs) Thronson, H. (Wyoming)	Survey of IRAS selected SO galaxies. 3.5 and 6 cm.
AB-507	Balkowski, C. (Meudon) Cayatte, V. (Meudon) Chamaraux, P. (Meudon)	A large HI cloud surrounding NGC 399. 20 cm line.
AB-508	Bastian, T. Anantharamaiah, K. Roelfsema, P. van Gorkom, J.	Search for recombination line radiation from the symbiotic binary H1-36. 2 and 3.6 cm line.
AB-524	Bregman, J. McNamara, B. (Virginia) van Gorkom, J. (Columbia) O'Connell, R. (Virginia)	HI in cooling flow cluster A2151. 20 cm line.
AC-207	Cornwell, T. Yusef-Zadeh, F. (NASA)	A unique HH object. 2, 6, and 20 cm.
AC-213	Curiel, S. (UNAM) Rodriguez, L. (CFA) Canto, J. (UNAM)	Central source of double Herbig-Haro objects. 6 cm.
AC-223	Cordova, F. (Los Alamos) Hjellming, R. Mason, K. (MRAO) Middleditch, J. (Los Alamos)	A potential "Ghost" SNR and filaments associated with PSR 0656+14 and the Gem-Mon SN remnant. 6 and 21 cm line.
AC-225	Churchwell, E. (Wisconsin) Wood, D. (CFA)	Systemic velocities and physical properties of ultracompact HII regions. 2 cm line.
AC-226	Carilli, C. van Gorkom, J. Stocke, J. (Colorado)	HI imaging of quasar galaxy pairs: 3C 232. 20 cm line.

No.	Observer(s)	Program
AC-227	Casertano, S. (Groningen) van Gorkom, J. (Columbia)	Late-type disk galaxies with extended HI envelopes. 20 cm line.
AC-230	Comins, N. (Maine) Owen, F.	3C 442. 90 cm.
AC-231	Claussen, M. (NRL) Gaume, R. (NRL) Johnston, K. (NRL) Wilson, T. (MPIR, Bonn)	The W3 (continuum) star-forming region. 1.3, 2, and 6 cm line.
AD-188	Drake, S. (SASC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in M Supergiant Alpha Ori. 2 and 6 cm.
AD-201	de Muizon, M. (Leiden) Braun, R. Oort, M. (Leiden) Roland, J. (Leiden)	SNR G70.7+1.2. 2, 6, and 20 cm.
AD-204	Duric, N. (New Mexico) Dittmar, M. (New Mexico) Crane, P.	Multi-frequency, scaled array study of 4 normal spiral galaxies. 2 cm.
AD-215	de Jong, T. (Amsterdam) van den Broek, A. (Amsterdam) van Driel, W. (Amsterdam)	Extreme IRAS galaxies. 6 cm.
AD-217	Drake, S. (SASC) Caillault, J. (Georgia)	Radio emission in the spotted BY Draconis stars. 6 cm.
AD-223	Dickel, H. (Illinois) Goss, W. M. Wilson, T. (MPIR, Bonn)	H66α recombination line emisssion from NGC 7538N. 1.3 cm line.
AD-228	dePater, I. (Berkeley) Palmer, P. (Columbia) Snyder, L. (Illinois)	Comet Machholz. 18 cm.
AE-53	Evans, N. (Texas) Zhou, S. (Texas) Mundy, L. (Caltech) Kutner, M. (RPI)	NH_3 observations of S140. 1.3 cm line.
AF-156	Fich, M. (Waterloo) Taylor, A. (Calgary)	Survey of discrete sources in the outer Galactic Plane. 6 cm.

No.	Observer(s)	Program
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Royal Obs.) Ade, P. (Queen Mary College) Robson, E. (Lancashire Polytech) Nolt, I. (Oregon) Smith, M. (Royal Obs.)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20, and 90 cm.
AG-247	Garrington, S. (NRAL) Laing, R. (RGO) Leahy, J. Conway, R. (NRAL)	Origin of depolarization asymmetry. 6 cm.
AG-256	Green, D. (DRAO)	Radio filaments in the Cygnus Loop and G84.2-0.8. 6 cm.
AG-259	Goss, W. M. Anantharamaiah, K.	Recombination lines from the external galaxy NGC 253. 6 and 20 cm line.
AG-264	Gavazzi, G. (IFC/CNR) Dickey, J. (Minnesota)	Disruption of spiral disks in the cluster A1367. 20 cm line.
AG-265	Goodman, A. (CFA) Myers, P. (CFA) Benson, P. (Wellesley) Fuller, G. (Berkeley)	Ammonia observations of dense gas in low-mass cores. 1.3 cm line.
AG-266	Garcia-Barreto, J. (UNAM)	Search for radio continuum emission from NGC 1022 and NGC 1326. 2, 6, and 20 cm.
AG-268	Garay, G. (Chile) Mendez, R. (Chile) Rodriguez, L. (CFA/UNAM) Murphy, D. (ESO)	Hot ammonia toward IRAS compact HII regions. 1.3 cm line.
AG-269	Ge, J. (NMIMT) Owen, F.	High Faraday rotation in cooling flow clusters. 3.6, 6, and 20 cm.
AG-270	Ge, J. (NMIMT) Owen, F.	3C 84. 6 cm.
AG-271	Gary, D. (Caltech) Zirin, H. (Caltech)	High-resolution studies of the quiet sun. 3.5 and 6 cm.
AH-284	Hollis, J. M. (NASA) Michalitsianos, A. (NASA) Kafatos, M. (George Mason)	Survey for large-scale structure associated with symbolic star system already showing small-scale radio structure. 6 cm.

No.	Observer(s)	Program
AH-293	Hanisch, R. (STScI) Miley, G. (STScI)	The rich X-ray cluster Abell 2256. 20 and 90 cm.
AH-299	Helfand, D. (Columbia) Becker, R. (Calif., Davis)	A 327 MHz survey of the galactic plane. 90 cm.
AH-306	Higgs, L. (DRAO) Landecker, T. (DRAO) Wendker, H. (Hamburg)	Sources in Cygnus-X. 6, 20, and 90 cm.
AH-307	Harnett, J. (MPIR, Bonn) Beck, R. (MPIR, Bonn) Buczilowski, U. (MPIR, Bonn)	The magnetic field in NGC 6946. 18 and 20 cm.
AH-309	Henning, P. (Maryland) Kerr, F. (Maryland)	A HI selected sample of galaxies. 20 cm line.
AH-310	Hogan, C. (Arizona) Partridge, R. B. (Haverford)	Search for cosmic background fluctuations at 23 GHz. 1.3 cm.
AH-314	Hummel, E. (NRAL) Harnett, J. (MPIR, Bonn) Beck, R. (MPIR, Bonn)	The magnetic field structure in NGC 877, 2076, 6907, and 7331. 6 cm.
AH-319	Ho, P. (Harvard) Szczepanski, J. (MIT)	Condensations in the G10.6-0.4 complex. 1.3 cm line.
AH-320	Heaton, B. (Kent) Macdonald, G. (Kent)	Compact ammonia cores in the bipolar outflow sources L 379 and IRS20188 + 3928. 1.3 cm line.
AH-322	Hummel, E. (NRAL) Beck, R. (MPIR, Bonn) Krause, M. (MPIR, Bonn)	Radio emission from edge-on spiral galaxies. 6 cm.
AH-324	Habbal, S. (CFA) Gonzalez, R. Harvey, K. (Solar Phys. Res.)	Multiwavelength observations of solar activity. 6, 20, and 90 cm.
AH-326	Ho, P. (Harvard) Martin, R. (Steward Obs.) Turner, J. (UCLA) Jackson, J. (Berkeley)	Extragalactic ammonia emission. 1.3 cm line.
AH-327	Ho, P. (Harvard) Jackson, J. (Berkeley) Szczepanski, J. (MIT) Armstrong, J. T. (Cologne)	Warm ammonia toward the galactic center. 1.3 cm line.

No.	Observer(s)	Program
AI-34	Irwin, J. (Toronto) Seaquist, E. (Toronto)	Radio continuum observations of NGC 4388 and NGC 5775. 6 cm.
AI-35	Inoue, M. (Nobeyama) Perley, R. Carilli, C. Kato, T. (Utsunomiya) Tabara, H. (Utsunomiya) Aizu, K. (Rikkyo)	High quality mapping of large Faraday rotation source Hyd A. 2 and 6 cm.
AJ-162	Johnston, K. (NRL) Pauls, T. (NRL) Wilson, T. (MPIR, Bonn)	Formaldehyde absorption toward Sgr A. 6 cm line.
AJ-165	Jackson, J. (Berkeley) Ho, P. (Harvard)	Ammonia in the circumstellar disk around NGC 6334 I. 1.3 cm line.
AJ-166	Johnston, K. (NRL) Gaume, R. (NRL) Wilson, T. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Schilke, R. (MPIR, Bonn)	Protostars in Orion: formaldehyde emission. 2 cm line.
AK-182	Kundu, M. (Maryland) Schmahl, E. (Maryland) White, S. (Maryland) Nitta, N. (Maryland)	Coronal magnetic structures using VLA microwave observations. 2.8, 6, and 20 cm.
AK-197	Kim, D. (UCLA) van Gorkom, J. Knapp, G. (Princeton) Guhathakurta, P. (Princeton) Walsh, D. (Princeton) Katz, N. (Princeton)	Search for HI in six elliptical galaxies. 20 cm line.
AK-198	Knapp, G. (Princeton) van Dishoeck, E. (Princeton) Bowers, P. (NRL)	HI distribution in the circumstellar envelope of Mira (o Ceti). 20 cm line.
AK-199	Kassim, N. (NRL) Erickson, W. (Maryland) Weiler, K. (NRL)	SNR candidates from the Clark Lake Galactic Plane Survey. 20 and 90 cm.
AK-201	Krause, M. (MPIR, Bonn) Beck, R. (MPIR, Bonn) Hummel, E. (MPIR, Bonn)	Polarization observations of IC 342 and M81. 6 and 20 cm.

No.	Observer(s)	Program
AK-205	Kirkpatrick, H. (Maryland) Wilson, A. (Maryland) Heckman, T. (Maryland)	Comparison of star-forming rates in Seyfert and normal galaxies. 20 cm.
AK-206	Kundu, M. (Maryland) White, S. (Maryland) Gopalswamy, N. (Maryland) Pick, M. (Paris)	Simultaneous microwave and decimeter observations of solar activity. 20 and 90 cm.
AK-209	Keto, E. (Livermore Lab) Klein, R. (Livermore Lab)	The temperature structure of the star forming region W33. 1.3 cm line.
AL-180	Lizano, S. (Berkeley) Shu, F. (Berkeley) Rodriguez, L. (CFA) Mirabel, I. (Puerto Rico)	The high velocity neutral stellar wind in HH7-11. 20 cm line.
AL-181	LaViolette, P. (Starburst)	The compact feature near the south-western tip of CTB 80. 2 and 6 cm.
AL-182	Little, L. (Kent) Heaton, B. (Kent)	Ammonia distribution in GGD12-15. 1.3 cm line.
AL-183	Linsky, J. (Colorado) Bookbinder, J. (Colorado) Doyle, J. (Armagh Obs.) Neff, J. (NASA) Skinner, S. (Colorado)	Coordinated multiwavelength observations of the RS CVn system EI Eridani. 2, 6 and 20 cm.
AM-235	Masson, C. (Caltech) Keene, J. (Caltech)	Search for dense gas around young stars. 1.3 cm line.
AM-238	Muhleman, D. (Caltech) Grossman, A. (Caltech) Thompson, T. (JPL) Goldstein, R. (JPL)	Radar imaging of Mars. 3.5 cm.
AM-239	Mirabel, I. (Puerto Rico) Ruiz, A. (Puerto Rico) Rodriguez, L. (CFA) Canto, J. (UNAM)	High velocity OH absorption toward selected outflow sources. 18 cm line.
AM-240	Mangum, J. (Virginia) Wootten, H. A. Mundy, L. (Caltech)	A study of the pre-stellar condensations in DR21(OH). 1.3 cm line.

No.	Observer(s)	Program
AM-242	Meaburn, J. (Manchester) Pedlar, A. (NRAL) Hummel, E. (NRAL) Clayton, C. (Cambridge)	Interlocking giant shells in the local group dwarf galaxy IC 1613. 6 cm.
AM-243	Morris, M. (UCLA) Yusef-Zadeh, F. (NASA)	Recombination line observations of the radio streamers near Sgr A. 6 cm line.
AM-244	Mundy, L. (Caltech) Blake, G. (Caltech)	Ammonia in the Orion molecular ridge. 1.3 cm line.
AM-245	Menten, K. (CFA) Reid, M. (CFA) Batrla, W. (Illinois)	Methanol in the NGC 6334F region. 1.3 cm line.
AM-246	Mauersberger, R. (IRAM) Wilson, T. (MPIR, Bonn) Johnston, K. (NRL) Pauls, T. (NRL) Henkel, C. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Schilke, R. (MPIR, Bonn)	Ammonia masers in W51. 1.3 cm line.
AM-247	Menten, K. (Smithsonian) Walmsley, C. M. (MPIR, Bonn) Schilke, P. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Johnston, K. (NRL) Pauls, T. (NRL)	Hot thermal methanol in Orion. 1.3 cm line.
AP-155	Paczynski, B. (Princeton) van Gorkom, J. Bally, J. (Bell Labs)	Search for CO emission from the quasars at z = 4. 1.3 cm line.
AP-157	Pauls, T. (NRL) Johnston, K. (NRL) Wilson, T. (MPIR, Bonn) Gaume, R. (NRL)	High density molecular clouds in the pre-collapse phase. 1.3 cm line.
AP-163	Pottasch, S. (Kapteyn Lab) Payne, H. Zijlstra, A. (Kapteyn Lab) Bignell, R. C.	OH emission from very young planetary nebulae. 18 cm line.
AP-164	Palmer, P. (Chicago) Yusef-Zadeh, F. (NASA) Goss, W. M. Lasenby, A. (Cambridge) Lasenby, J. (Cambridge)	Continuum observations of Sgr B1/ Sgr B2 complex of HII regions. 2, 6, and 20 cm.

No.	Observer(s)	Programs
AR-167	Roeser, H. (MPIA, Heidelberg) Perley, R. Hiltner, P. (MPIA, Heidelberg) Meisenheimer, K. (MPIA, Heidelberg)	Optically identified hotspots in classical double radio sources. 2, 6 and 20 cm.
AR-168	Rusk, R. (Toronto)	Radio polarimetry of 1807+698 (3C 371). 6 and 18 cm.
AR-173	Richards, P. (Rutherford/Appleton) Heaton, B. (Kent)	Ionized gas in IRAS compact molecular clouds. 2 cm.
AR-180	Rudnick, L. (Minnesota) Anderson, M. (Minnesota)	Large-scale shock structures driven by the jets of SS 433. 20 cm.
AR-181	Riley, J. (MRAO) Warner, P. (MRAO)	Radio structure of 4C 74.26--the largest-known quasar. 20 and 90 cm.
AR-184	Roelfsema, P. Seaquist, E. (Toronto)	Recombination lines in M82. 3.5 and 6 cm line.
AR-185	Roelfsema, P. Goss, W. M.	H, He, and C 92α observations of W3. 3.5 cm line.
AR-186	Rodriguez, L. (CFA) Moran, J. (CFA) Canto, J. (UNAM)	The bipolar HII region NGC 6334(A). 6 and 20 cm line.
AR-187	Reipurth, B. (ESO, Chile) Rodriguez, L. (CFA)	Radio continuum from the luminous Herbig-Haro objects 80 and 81. 6 cm.
AR-188	Roelfsema, P. Bastian, T. Anantharamaiah, K.	Recombination lines from supernova remnants. 20 cm line.
AS-319	Simon, A. (NRL) Fiedler, R. (NRL) Dennison, B. (NRL) Johnston, K. (NRL) Spencer, J. (NRL)	Extreme scattering events. 2, 4, 6, 20, and 90 cm line.
AS-325	Sukumar, S. (Illinois) Allen, R. (Illinois)	NGC 5236 (M83). 20 cm.
AS-326	Sukumar, S. (Illinois) Allen, R. (Illinois)	Edge on galaxy NGC 4565. 20 cm.
AS-328	Singh, K. (TIFR) Patnaik, A. (TIFR)	Survey of a compact group of galaxies: 2A0335+096. 20 cm.

No.	Observer(s)	Programs
AS-329	Subrahmanyan, R. (TIFR) Gopal-Krishna (TIFR) Swarup, G. (TIFR)	Continuum observations of Orion A and Orion B. 90 cm.
AS-333	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (SRZM) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6, and 20 cm.
AS-334	Siemieniec, G. (MPIR, Bonn) Urbanik, M. (Krakow) Beck, R. (MPIR, Bonn) Hummel, E. (NRAL)	The radio disk of NGC 3628. 20 cm.
AS-336	Simkin, S. (Michigan State) van Gorkom, J.	A search for very extended HI envelopes. 20 cm line.
AS-341	Snell, R. (Massachusetts) Schloerb, F. (Massachusetts)	Continuum emission from nearby giant molecular clouds. 6 cm.
AS-342	Schneider, S. (Massachusetts) Young, J. (Massachusetts)	An HI study of IC 356. 20 cm line.
AS-343	Schneider, S. (Massachusetts) Hacking, P. (IPAC)	A high-galactic latitude cirrus cloud. 20 cm.
AS-345	Shaw, M. (Manchester) Wilkinson, A. (Manchester)	The radio properties of box/peanut galactic bulges. 20 cm.
AS-347	Schmelz, J. (NASA) Gonzalez, R. Saba, J. (NASA) Strong, K. (NASA)	Stereoscopic coronal structures observing campaign (SCoStOC). 6, 20 and 90 cm.
AS-348	Skinner, S. (Colorado) Bookbinder, J. (Colorado) Fleming, T. (Arizona) Linsky, J. (Colorado) Stocke, J. (Colorado)	The stellar component of the Einstein medium sensitivity survey: the lower main sequence. 6 cm.
AT-90	Taylor, A. (Calgary) Waters, L. (LSR, Utrecht) Bjorkman, K. (Colorado) Persi, P. (IAS)	Radio survey of IRAS selected Be stars. 2 and 3.5 cm.

No.	Observer(s)	Programs
AT-92	Torrelles, J. (Inst. Ast. Andalucia) Ho, P. (Harvard) Szczepanski, J. (MIT) Rodriguez, L. (CFA) Canto, J. (UNAM)	MONR2: A shell-like high density structure produced by the pressure of the supersonic outflow. 1.3 cm line.
AT-96	Turner, J. (UCLA) Ho, P. (Harvard)	Star formation in the spiral arms of IC 342. 2 cm.
AU-34	Uson, J. (Berkeley) Bagri, D.	Search for redshifted 21 cm emission from Zel'dovich pancakes. 90 cm line.
AU-35	Ulvestad, J. (JPL)	Thermal emission from Markarian 231. 2 cm.
AV-134	Vanden Bout, P.	Compact HII regions in S88B. 6 cm.
AV-158	Viallefond, F. (Meudon) Zheng, X. (CFA) Boulanger, F. (Caltech)	Radio continuum survey of M33 at 327 MHz. 90 cm.
AV-159	van Gorkom, J. Hibbard, J. (Columbia)	The riddle of NGC 4438. 20 cm line.
AW-173	Wilking, B. (Missouri) Mundy, L. (Caltech) Howe, J. (Texas)	A survey of cold IRAS sources. 2 cm.
AW-211	Williams, B. (Delaware) van Gorkom, J.	HI synthesis of three compact groups of galaxies: HCG 44. 20 cm line.
AW-217	White, S. (Maryland) Kundu, M. (Maryland) Schmahl, E. (Maryland) Nitta, N. (Maryland)	Solar coronal bright points. 3.5, 6, and 20 cm.
AY-24	Yusef-Zadeh, F. (NASA) Palmer, P. (Chicago)	The Orion nebula. 2 and 6 cm.
AY-25	Yin, Q. (Peking) Heeschen, D. Saslaw, W. (Virginia)	Optically selected starburst galaxies. 1.3, 2, 6 and 20 cm.
AY-26	Yun, M. (Harvard) Ho, P. (Harvard) Lo, K. (Illinois)	HI synthesis mapping of M82. 21 cm line.

No.	Observer(s)	Programs
AY-27	Yusef-Zadeh, F. (NASA)	Orientation of the magnetic field near the galactic center. 3.5 and 6 cm.
AY-28	Yusef-Zadeh, F. (NASA) Morris, M. (UCLA) van Gorkom, J.	Recombination line emission from G0.15-0.05. 2 cm.
AZ-31	Zhao, J. (New Mexico) Burns, J. (New Mexico) Owen, F.	Extensive observations of turbulent radio jets in cluster galaxies. 6 and 20 cm.
AZ-37	Zhou, S. (Texas) Evans, N. (Texas) Mundy, L. (Caltech)	Probing the collimating disk of NGC 2071 IRS. 1.3 and 6 cm line.
VH-44	Hewitt, J. (Haystack) Bookbinder, J. (CFA) Cappallo, R. (Haystack) Corey, B. (Haystack) Hinteregger, H. (Haystack) Lestrade, J. (Paris) Lonsdale, C. (Haystack) Niell, A. (JPL) Phillips, R. (Haystack) Preston, R. (JPL)	dMe Stars. 3.6 cm phased array MK III VLB.

F. SCIENTIFIC HIGHLIGHTS

Solar Microwave Emission

As part of an ambitious program of microwave, X-ray, and optical observations of the Sun during the month of September 1988 (designated International Solar Month by the IAU), T. Bastian, S. Habbal, R. Gonzalez, G. Dulk, and T. Cornwell have employed bandwidth synthesis techniques to image the Sun at 3.6, 6, 20, and 90 cm on four consecutive days with the VLA. The observing program was designed to follow the temporal evolution of the microwave emission from solar active regions. Active regions are areas on the Sun where strong magnetic fields have erupted through the photosphere, forming an ensemble of coronal magnetic loops which are anchored in sunspots. As their name implies, active regions are associated with most forms of transient solar activity, e.g., flares, noise storms, filament eruptions, coronal transients, etc.

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

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

6 cm Source Survey Carried Out by the 300-ft Telescope

The results from the October 1987 observing run have been completely reduced. Approximately 6 steradians of sky, between 0 and 75 degrees declination, have been surveyed at a frequency of 4.85 GHz to a completeness level of 25 mJy. Some 10,000 sources per steradian have been found. Position uncertainties range from 10 to 30 arcseconds in each coordinate. The complete sample is available in FITS format on magnetic tape. This survey constitutes a radio analog to the IRAS survey, the Einstein survey, and the Palomar Observatory Sky Survey. The October 1987 data will constitute a first epoch from which variable sources can be detected in subsequent surveys. Subsequent surveys will also lower the noise level and increase the number of sources.

Interstellar Chemistry, 140-ft Telescope Observations

The molecule methylamin was said to have been found in the direction of the Galactic Center in 1974. No subsequent observations ever confirmed its presence, however. And the original detection spectrum had sufficiently poor signal-to-noise that methylamine was in danger of being dropped from the list of detected molecules. Its existence has at last been confirmed with high enough sensitivity that five hyperfine transitions are apparent, definitive proof of the correct identification. Again, the molecule was found only in the direction of the Galactic Center.

A new interstellar radical, the cyanomethyl radical (CH_2CN), has been found in a spectral survey of cold, dark clouds. The initial transition found, at approximately 20 GHz, has been followed up at other telescopes where transitions at 40, 80, and 100 GHz leave no doubt that the identification is correct. The distribution of CH_2CN is similar to that of such carbon chain species as HC_5N and C_4H. The abundance is considerably greater than that of methyl cyanide.

G. PUBLICATIONS

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

H. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

The Central Development Lab's contribution to this project is now essentially complete. Future involvement will be in supplying spare parts, including lower noise HEMT amplifiers than those currently in some of the receivers. These amplifiers could be retrofitted in some of the higher noise receivers that may need service for other reasons. Improvements in performance would be in the range 3-8 K.

Cooled HEMT Amplifier Development

The upgrade of L-band GaAs FET amplifiers with HEMT's continues. The supply of devices is no longer a problem since we now have a number of Mitsubishi devices from a batch with good cryogenic performance.

During this quarter, ten 8.8 GHz and seven 22 GHz amplifiers have been built for VLA and VLBA projects.

During this same period, a four-stage, 43 GHz amplifier has been completed and tested. The amplifier has 24 dB gain and 45 K noise temperature and would meet VLBA requirements. However, the transistors used in the amplifier are samples from the General Electric Research Laboratory, and the 100 chips needed for 22 VLBA amplifiers are not available. Other sources or a contract with GE will be explored.

Orbiting Submillimeter Telescope (OST) Proposal

During this quarter assistance was provided in the preparation of a proposal for a small-class explorer mission (SMEX). The proposal is to launch, into low-earth orbit using a Scout rocket, a 0.9 m dish with uncooled receivers and spectrometers. There would be a total of 10 channels covering 119, 492, 548, 557, and 576 GHz for observations of various molecular lines which cannot be adequately observed from the ground because of atmospheric absorption. NASA expects to announce the selected proposals April 1989.

Superconducting (SIS) Millimeter-Wave Mixer Development

We have received two new wafers of mixer junctions from Hypres. Included on this mask set are 115 GHz and 230 GHz mixers with inductive tuning elements, and some experimental, fully integrated mixers which will require no external tuners. The first wafer of this design was delivered during the last quarter, but due to difficulties in the fabrication process, most of the junctions were either short-circuits or of poor quality. The mixers on the second wafer had normal resistances lower than desired by a factor of 2-3. Nevertheless, at 200 GHz we measured an overall receiver noise temperature of 113 K DSB, which includes the contribution of the room temperature horn and input waveguide of the laboratory test receiver. The third wafer was heat treated to reduce the critical current density and increase the impedance levels of the mixers; this has not been tested yet. The Hypres mixers are fabricated using their Nb/Al-

Al_2O_3/Nb trilayer process under a no-cost collaborative agreement. The seven masks for this process were laid out using UVA mask design facilities.

We have supplied a 90 GHz mixer to Dr. P. Lubin at University of California, Santa Barbara, for use on their balloon-borne cosmic background radiometer. Using a receiver with a low-loss quasi-optical input, a receiver noise temperature of 33 K DSB was obtained. This mixer uses one of our older Hypres junctions without an integrated tuning structure.

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

The Nb/Al-Al_2O_3/Nb trilayer process (similar to that of Hypres) for fabricating superconducting circuits appears to be the best available for millimeter-wave SIS mixers. This process is being implemented at UVA as part of a collaborative effort with NRAO to develop better SIS mixers. We expect the UVA collaboration to give us the responsive source of SIS junctions we need to develop mixers for other frequency bands and to explore quasi-optical mixers--e.g., the Phillips planar-spiral mixer--without the great cost and delays of using a commercial source of junctions. The UVA process is producing excellent trilayer material, as is evident from the I-V characteristics of test junctions. However, relatively minor difficulties in the five lithography steps have delayed the production of useful mixer junctions.

During this quarter we have tested a total of 22 SIS mixers, mostly for 230 GHz operation and mostly from the faulty Hypres wafer mentioned above.

Schottky Diode Millimeter-Wave Mixer Development

In support of the 12-m telescope this quarter, we have re-built and tested a total of 11 Schottky mixers and multipliers in the 230, 300, and 345 GHz bands.

The new 270-310 GHz mixers are now in use on the 12-m telescope. So far, we have only used UVA 2I1 diodes in these mixers, the best of which give mixer noise temperatures of 1000-1500 K SSB. We plan to test other diodes in these mounts when time permits. On the telescope a receiver noise temperature of 1200-1500 K SSB is obtained over most of the 270-310 GHz range.

We have now stopped all development of new Schottky diode mixers, and will continue Schottky work only as needed to service receivers for the 12-m telescope and site-testing atmospheric receivers.

I. GREEN BANK ELECTRONICS

300-ft Spectral Processor

The Spectral Processor project is now entering the system testing phase. The digital boards required for one-half of the total system (40 MHz, 1024 channels) have been constructed and tested individually. During the system tests, now beginning, these boards will be installed in the system racks and tested as an integrated system. Test data will be injected and correct hardware operation confirmed.

Work on the IF/Video converters continued. All the components required for the first unit have been constructed and tested and are being integrated into a chassis. Completion is expected by mid-October.

140-ft Cassegrain Receivers

Over the past few years, users of the 140-ft Cassegrain system have noted a gradual decline in performance of the B receiver maser. The entire 5 to 25 GHz frequency range has been affected. The most serious problem was an abnormally high ripple in instantaneous gain response over most of the tuning range. Tuning was difficult, and when the observing frequency coincided with a gain null (usually the case) the result was high noise temperature, often 50 percent higher when compared with the A receiver. There was also a tendency to oscillate. The receiver was removed from the telescope in July 1988 and the following problems identified.

1. Two of the four rubies were nearly identically phased instead of being staggered. The waveguide structure may have relaxed over time causing this. A different mix of rubies in their waveguides and a slight lapping of one of them resulted in almost perfect phasing.

2. In the circulator assembly, it was found that the cement holding the ferrite discs was flexible enough so that eight of the ten ferrites mounted on the center plate were being displaced on application of the ferrite magnetic field thus changing the air gap and affecting the match. The entire assembly was stripped of ferrites and alumina matching blocks and rebuilt to the original design.

3. The permanent magnets for the circulator ferrites had weakened so that the average flux density was low by about 15 percent. These were replaced with new magnets.

4. Thermal resistance had increased between the top liquid helium heat exchanger and the maser structure. The rubies were then at a slightly elevated temperature, and overall maser gain was suppressed by about 3 dB.

5. The waveguide for pumping the rubies had cracked and the loss was measured at 1 to 10 dB, depending on force applied to the waveguide. This lowered the maser gain-bandwidth product and contributed to instability.

6. The superconducting magnet current loop had a defective weld causing a drifting field, failure to lock up, and difficulty in tuning.

All of these problems have been corrected and the receiver has been re-installed on the telescope. It appears that, on average, bandwidth and noise temperature are now somewhat better than for the A receiver over most of the tuning range. Maser frequency range can be taken to be 18.0 to 25.16 GHz. There are narrow band (typically 40 MHz) responses below 18 GHz; the high end frequency limit is firm. Users are reminded that many observing constraints imposed by past performance will no longer apply.

S/X Receivers

The USNO is funding the design and construction of new cryogenic receivers for the Green Bank three-element interferometer. The major design tasks under way are:

1. Receiver Design - All receivers will be dual polarization, dual frequency, prime-focus receivers operating at center frequencies of 2.3 and 8.4 GHz. Cooled HEMT amplifiers of existing designs will be utilized. The first cryogenics dewar package has been completed and tested, yielding noise temperatures of 12 K at 2.3 GHz and 15 K at 8.4 GHz. The dewar is now being integrated into a front-end box with the feed and other components.

2. Feed Design - A coaxial feed design using a wide-flare horn with dual-depth corrugations and a dielectric cone X-band section has been adopted. The first feed has been constructed and shows acceptable performance. The spill-over temperature at both bands is approximately 3 K, and the return loss is greater than 20 dB in the frequency ranges of interest.

3. Control Computer - The 85-3 antenna will be operated as a VLBI antenna in conjunction with other USNO antennas. This necessitated a new control computer, interface, and control program. A fast AT class PC was selected as the control computer and the control program is now complete. The antenna is controlled over a serial bus (with optical fiber link) from the Interferometer control building.

4. Data Link - The MKIII VLBI terminal located at the 140-ft will be used with the 85-3 observations and a link will be installed between the two telescopes, sending single polarization, S-band, and X-band IF signals. The IF signals will be frequency multiplexed onto a wide-band, single-mode optical fiber. The fiber cable has been installed and the broadband transceivers received and tested. The frequency multiplexers are under construction.

Miscellaneous

Six 4.8 GHz cooled HEMT amplifiers were completed this quarter for VLA receivers. HEMT amplifiers in the 2-5 GHz receiver were replaced with lower noise 4.8 GHz amplifiers, resulting in receiver noise lower by about 4 K.

S/N 5 and 6 VLBA 1.5 GHz front-ends were completed and tested, and S/N 7 VLBA 4.8 GHz front-end is 90 percent completed.

J. 12-M ELECTRONICS

Receiver Status

70-115 GHz Schottky Mixer Receiver - The high frequency dewars (90-115 GHz) on this receiver have been dismantled as this frequency range is now covered by the SIS 90-115 GHz receiver. It is hoped that the 70-90 GHz frequency range will be replaced by a new SIS receiver during the next year.

200-350 GHz Schottky Mixer Receiver - This dual channel receiver is unchanged since the last quarterly report.

90-115 GHz SIS Receiver - This receiver is unchanged since the last report. Noise temperatures of 100-150 K SSB are obtained over the 90-115 GHz frequency range.

Eight-Beam 230 GHz Receiver - This Schottky mixer receiver is completed and is awaiting the completion of the hybrid spectrometer to be placed into service.

Next Generation SIS Receiver - Work has started on a new series of receivers to cover the 70-115 GHz and 200-360 GHz bands. The receivers will use a series of mini-dewars and closed-cycle refrigeration systems to cover the required frequency bands. A prototype mother-dewar and mini-dewar have recently been successfully tested in Green Bank.

Hybrid Spectrometer - Work continues on the hybrid spectrometer. We are aiming at telescope tests before the end of the year.

K. VLA ELECTRONICS

Improvements In Antenna Pointing

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

An important pointing problem now being investigated is the occurrence of tilts of up to 20 arcsecs in the azimuth axis of a few antennas at certain azimuth angles. This effect is believed to be caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Testing of the stability of two redesigned tilt-meter units showed that the temperature control of the tiltmeter meter unit is now adequate for detailed tests to begin.

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. Testing of this feed and its effect on other frequencies will continue into next quarter. With the new feed installed near the focus of the antenna, locally generated radio frequency interference became a significant problem (see RFI Improvements). Four antennas are equipped with the 75 MHz system. NRAO has an agreement with NRL for further outfitting. The first level of funding (for four more systems) has been received and components are being procured.

VLA 327 MHz Receiver

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

The receiver has been designed so that observations in the range 300-340 MHz can be made with an instantaneous bandwidth of approximately 12 MHz. At this low frequency, the VLA 25-m diameter antennas can only be used in prime focus mode. It is known that radio-frequency interference, both locally generated at the VLA and from external sources, will be a significant problem.

Twenty-one antennas now have 327 MHz receivers installed, and this system is scheduled for completion by December, 1988. To reduce local RFI, RFI enclosures for the vertex mounted "B" racks have been installed on four antennas (see RFI Improvements).

VLA 8 GHz Receivers

Feeds and front-ends covering the frequency range 8.0-8.8 GHz are being installed on the VLA primarily to augment the NASA/JPL DSN reception of the Voyager signal from Neptune at 8415 MHz. Other scientific benefits include the provision of an additional frequency for measurements of continuous spectra and joint observations with the VLB array. The 8.4 GHz front-ends enabled the VLA to be used in a successful planetary radar experiment with the Goldstone transmitter. The NRAO Central Development Laboratory has developed this front-end which was using GaAs FET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers have been incorporated into these systems during this quarter.

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

JPL has provided funding for this project. Antennas being overhauled will be outfitted with X-band feed towers. Installation of the remaining three X-band systems will be completed in January, 1989.

RFI Improvements

The sensitivity of the 327 MHz and 75 MHz systems will be limited partly by radio-frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous usable bandwidth were investigated. A modification to allow the Monitor and Control system to free run eliminated most of the coherent RFI between antennas. However, the remainder still limits use of the 327MHz system, so enclosing the radiating components with RFI shields is necessary.

Four prototype RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosures have not been procured due to an increase in cost by a factor of two. These RFI enclosures eliminate the remaining antenna-generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. A method to reduce this interference is being investigated. No progress has been made during 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 required at each VLBA station. Second, the radiometer can be used at the VLA to provide estimates of the extinction, giving corrections for observations at 1.3 cm and serving as a historical record of the quality of the VLA site. Finally, if a reliable system can be built at a sufficiently low cost, it would be attractive to add them to the VLA itself.

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

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

1.3 cm Receiver Upgrade

Many important ammonia line experiments, such as accretion disks, circumstellar material, distant star-forming complexes, and extragalactic ammonia, will benefit from the upgrade in K-band performance. The projected improvement at 24 GHz by a factor of 3 means a tremendous boost in speed and sensitivity. Experiments will be ten times faster. Eight-hour experiments will then take less than 1 hour. Instead of one region per u-v track, approximately 10 regions can be studied at once. This is a very significant step forward.

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

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

1.3-1.7 GHz T_{sys} Improvements

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

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

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

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

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

L. AIPS

Most of the AIPS effort over the past quarter has been on the "code overhaul" in which the AIPS source code is being converted from its old standards to a strict ANSI Fortran 77 standard with certain specific additions. (See previous Quarterly Report - April 1, 1988 - June 30, 1988.) Some minor bug fixes have been made. In addition, a major effort was directed toward filling two new AIPS positions, a programmer and a manager, to be located at the VLA Site.

M. VLA COMPUTER

Sporadic signal drops in the received signal from Voyager were found to be a result of a problem with the on-line computer systems. With help from the computer manufacturer, this problem has been identified and corrected. New developments in the on-line system have been largely on hold while this work was in progress.

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

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

The Interactive Spectral-line Imaging System (ISIS), the successor to the pipeline software running on the Convex computer, now has a set of calibration applications which are substantially complete. The system is still under development; it is released only for internal experts. This has been delayed due to manpower re-organization to assist with the on-line system.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The September - October Network User Group run at 2.8, 1.3, 3.6 cm at Pie Town was the first VLBA remote controlled, largely unattended NUG run. Operators, site technicians, and astronomers at the Socorro VLBA office now use a terminal office for communication with the Pie Town station computer.

The previously reported azimuth rail flatness problem is apparently solved. At Fort Davis, a new installation process obtained a flatness within the 0.01 inch specified tolerance. The correction of the three previously constructed antennas is underway. The antenna contractor is grinding and filling the rails, and using the new grouting and measuring methods to bring them within the specifications.

The second subreflector has been delivered to the Kitt Peak site. It measured slightly better than the 0.006 inch RMS production tolerance at 2000 points. The third subreflector is completed and currently awaiting inspection by NRAO at the factory. The fabrication of all main reflector precision panels, including spares, is completed.

Site status - Phase II mechanical and electronic outfitting, including installation of the focus/rotation mount and subreflector, are scheduled for the Kitt Peak site in October, and the Los Alamos site in February. The Fort Davis antenna received its "punch list" acceptance inspection in early September. Antenna erection proceeds at North Liberty, IA, and is scheduled for completion in November. At Brewster, WA and Owens Valley, CA the site preparations, antenna foundations, and control buildings are complete, awaiting antenna erection. The St. Croix, VI, Mauna Kea, HI, and Hancock, NH locations are in lease approval stage.

Electronics

In the area of the receiver front ends, most of the construction planned for the calendar year was completed, with the exception of the units for the 23 GHz band. The first 23 GHz front end has been installed on the Pie Town antenna, but requires the addition of some ambient-temperature amplifiers to increase the gain. These amplifiers are on order, and will be retrofitted during the coming quarter. Two other 23 GHz front ends are almost complete, and two more are about half finished.

The electronics racks (A, B, and C) for systems through serial number 7 have almost been completed. One unit of Rack A and the converter modules for systems 6 and 7 have yet to be assembled. Overall, good progress has been made towards the planned goal of completing the electronics (Racks A, B, and C and front ends) for systems through serial number 7 by the end of this year.

Construction of the Data Acquisition racks (Rack D) in Charlottesville, which was started during the second quarter of this year, has continued. The required documentation from Haystack Observatory has been acquired, parts procured, and the bins for the first rack assembled and wired. Assembly of the first modules for this rack is now in progress.

During the quarter the decision was made to suspend development of the SIS mixer for the 43 GHz band, pending testing of the first HEMT amplifier for 43 GHz. Tests of the HEMTs showed promise of obtaining a satisfactory receiving system, with simpler cryogenic requirements than the SIS mixers. The latest results on the HEMT amplifier, a three-stage prototype of which has now been completed, show a gain of 24 dB and a cooled noise temperature of just under 50 K, for a bandwidth of 1 GHz.

On the maser contract, units through serial number 7 have been completed and tested at Sigma Tau Standards Corporation, and work is continuing on units 8 and 9. Tests of the two masers that were sent to JPL for evaluation earlier in the year should be completed by the end of October.

Data Recording

The first VLBA Data Acquisition System, in MK III mode at Pie Town, has been operated remotely from Socorro, NM, during the September - October NUG runs. Processing at Haystack Observatory indicated good signal quality. Work on field testing, firmware debug, and VME computer control software continued during the quarter.

During the third quarter, construction of Recorder 2 was completed. Preproduction Recorder 3 is almost complete, allowing Haystack to initiate the estimation of their production costing and capacity. Preproduction Data Acquisition Racks 3 and 4 were also completed and ready for testing except for formatter 4, due for completion in November.

Construction of the first Playback Drives, 1 and 2, is underway. The first is scheduled by Haystack for completion at year's end; the second in early spring.

Testing continued on samples of advanced (D1 and D2) magnetic tape samples at Haystack. Such effort is scheduled to be accelerated in 1989.

Monitor and Control

During third quarter 1988 work continued on the station computer astronomical observing routines, with emphasis on the controlling software for the tape recorder and formatter; and with reliability issues. The CHECKER routines have been brought to a useful, though far from complete, level. The second focus/rotation control equipment (for Kitt Peak) has been completed and entered the first phase of laboratory testing.

The modified Pie Town weather station seems to be operating reliably at the site. Analysis of the pointing accuracy tests of the Pie Town antenna are proceeding. All of the necessary software is present, albeit somewhat inconvenient to use at the moment.

The Motorola X-25 product that we have been planning to use at the sites for the software interface to the central VAX has been delayed beyond the originally expected delivery date. We expect to receive this device in October.

Correlator

Four bidders submitted apparently responsive proposals in reply to the revised request for proposals for final design, prototyping, and fabrication of the correlator "FX chip." The best of those that met NRAO requirements was submitted jointly by Hall-Mark Electronics and LSI Logic Corporation, and this proposal was recommended for award of the FX chip procurement. After approval by the National Science Foundation, a purchase order was issued to Hall-Mark on 1988 September 20. Under the joint proposal, Hall-Mark will provide design services at their center in Columbia, MD, while LSI Logic will fabricate the prototype and production chips based on the final design. The work is to be performed in five phases, at a total cost of $392,745, some 10 percent over the amount budgeted. Final terms of the expected contract are presently being negotiated.

A request for proposals was prepared for fabrication of the four major circuit boards which comprise the bulk of the correlator proper as well as the playback interface (formally part of the data playback system but integrated into the correlator in the interests of efficiency). This RFP is ready to be submitted as soon as preliminary layouts for all boards are complete. Procurement of the correlator FFT and multiplier/accumulator boards will have to be matched to progress in design and prototyping of the FX chip: the chip pin configuration must be determined before final board layout can be specified, and the boards will be required for thorough testing of the prototype chips.

The software development and eventual correlator control environment was decided, and procurement begun on a workstation complex which will run under the Unix operating system and provide a computer-aided software engineering facility. The workstations will use Motorola 680x0 processors to facilitate exchange of executable code and binary data with the 680x0-based real-time complex, and should also incorporate the VME bus standard to allow a common interface to peripherals.

Evaluation of several possible alternative operating systems for the real-time complex was started. Use of the VersaDos real-time system, already incorporated into the VLBA array control system, may impose disadvantages such as reduced programmer efficiency and more complex interprocessor communications. Several alternative real-time operating systems incorporate standard software solutions for the correlator's internal communications requirements, and provide more modern code development and debugging facilities. However, this option impacts long-term maintainability by requiring continuing expertise in two different VLBA real-time operating systems. The relative merits of both choices are under study.

Data Processing

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

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

Significant progress has been made in the search for an astrometrist.

Array Operations Center

New Mexico Institute of Mining and Technology expects the contractor to turn the building over to their maintenance staff on October 31. Tech expects to make it available for occupancy to NRAO a week or two later.

O. PERSONNEL

New Hires

Westpfahl, D.	Asst. Scientist/Education Officer	07/05/88
Ghigo, F.	Asst. Scientist/Green Bank Oper.	08/12/88
Hankins, T.	Visiting Scientist (P/T)	08/15/88
Kashlinsky, A.	Visiting Research Associate (Temp.)	09/01/88
Batrla, L. W.	Asst. Scientist/Green Bank Oper.	09/07/88

Terminations

Kapahi, V.	Visiting Associate Scientist	07/05/88
Dinius, M.	Business Manager/VLA	07/31/88
Tifft, W.	Visiting Scientist	08/12/88
Roelfsema, P.	Research Associate	09/13/88

Promotions

Fisher, J. R.	to Scientist/Continuing Appt.	07/01/88
Cornwell, T.	to Scientist	07/01/88
Payne, J.	to Scientist/Continuing Appt.	07/01/88
D'Addario, L.	to Scientist/Continuing Appt.	07/01/88
Porter, W.	to Business Manager/Socorro Oper.	08/01/88
Dowling, J.	to Asst. Business Mgr/Socorro Oper.	08/01/88

Other

Rots, A.	return from Leave of Absence	08/01/88
Sramek, R.	Leave of Absence	08/26/88
van Gorkom, J.	Leave of Absence	09/01/88
Uson, J.	Leave of Absence	09/16/88

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