NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

January 1, 1988 - March 31, 1988

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A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1902.00	2047.25	1925.50	1345.7
Scheduled maintenance and equipment changes	131.25	106.00	96.25	529.8
Scheduled tests and calibrations	61.75	6.75	162.25	314.5
Time lost	181.75	66.50	165.25	-
Actual observing	1720.25	1980.75	1760.25	1216.5

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
B-494	Backer, D. (Berkeley) Bookbinder, J. (Colorado) Dulk, G. (Colorado) Kulkarni, S. (Caltech) McKean, M. (Colorado) Bastian, T.	Observations at 1400 MHz of the dynamic spectra of dMe flare stars and RS CVn binaries.
U-22	Uson, J.	Observations at 1.5 cm of a small-scale anisotropy of the microwave background.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-88	Radhakrishnan, V. (Raman) Shukre, C. (Raman) Anantharamaiah, K.	Observations at 6 cm toward the galactic center to confirm the possible detection of positronium.
B-481	Bell, M. (Herzberg) Matthews, H. (Herzberg)	Search at 19.5 GHz for K-band transitions of C_8H.
B-492	Bell, M. (Herzberg) Feldman, P. (Herzberg) Matthews, H. (Herzberg)	Sensitive survey at 1.3 cm of a portion of the centimeter wave spectrum of IRC+10° 216.

No.	Observer(s)	Program
H-237	Baan, W. (Arecibo) Henkel, C. (MPIR, Bonn) Batrla, W. (Illinois) Cox, P. (MPIR, Bonn) Gusten, R. (MPIR, Bonn)	Search at 1.2 cm for ammonia in Cen A.
I-5	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Hjalmarson, A. (Chalmers) Madden, S. (Massachusetts) Ziurys, L. (Massachusetts) Turner, B.	Observations at 1.5 cm of molecular clouds, particularly the cold clouds TMC-1 and L134N.
I-10	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Matthews, H. (Herzberg)	Observations over the range 19.5 - 24.3 GHz to study oxygen-bearing interstellar molecules in cold clouds.
M-227	Matthews, H. (Herzberg) Batrla, W. (Illinois) Caswell, J. (CSIRO) Haynes, R. (CSIRO) Olnon, F. (Leiden) Winnberg, A. (Chalmers) Maddalena, R.	Observations at 1.3 cm for H_2O maser sources in the galactic plane.
S-314	Snyder, L. (Illinois) Batrla, W. (Illinois) Henkel, C. (MPIR, Bonn) Walmsley, M. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Jewell, P.	Observations at 20.2, 21.8, and 23.3 GHz to confirm the detection of CH_3C_5N (methylcyanodiacetylene) in TMC-1.
T-221	Turner, B. Barvainis, R. (Haystack)	Observations at 3 cm of the Zeeman effect of the C_4H molecule to measure magnetic fields in star forming cores of molecular clouds.
T-234	Turner, B. Sears, T. (BNL)	Search at 1.4 cm for the HCCO radical.
T-242	Tifft, W. (Arizona)	Refined observations of HI redshifts in about 100 galaxies to verify and enhance data taken at the Bonn 100-m and the NRAO 300-ft telescopes.
Z-65	Ziurys, L. (Massachusetts) Snell, R. (Massachusetts)	Studies at 1.3 cm of the physical and chemical properties of the shocked gas of IC 443.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
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 millisecond pulsars.
B-500	Backer, D. (Berkeley) Dey, A. (Berkeley) Gorham, P. (Caltech) Kulkarni, S. (Caltech) Middleditch, J. (Los Alamos) Prince, T. (Caltech)	Targeted pulsar search at 20 cm.

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

A - Arecibo 1000 ft
B - Effelsburg, MPIR 1000 m
E - Hartebeesthoek 26 m
F - Fort Davis 85 ft
G - Green Bank 140 ft
H - Hat Creek 85 ft
I - Iowa 60 ft
Jb - Jodrell Bank MK II 25 m
Km - Haystack 120 ft
Lb - Bologna 25 m
Lm - Medicina 32m
Ma - Nobeyama 45 m
Mb - Itapetinga 20 m
N - NRL Maryland Pt. 85 ft
O - Owens Valley 130 ft
Sn - Onsala 20 m
So - Onsala 25 m
Wn - Westerbork n=1-14x26 m
Yn - Socorro n=1-27x25 m
Z - Torun 15 m

No.	Observer(s)	Program
B-82V	Barthel, P. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech)	Observations at 6 cm of the morphological evolution of two new superluminal quasars, with telescopes B, F, G, H, I, Jb, Km, Lm, O, So, Wn, and Yn.
B-83V	Biretta, J. (CFA) Junor, W. (Manchester) Muxlow, T. (Manchester) Reid, M. (CFA) Spencer, R. (Manchester)	Observations at 6 cm of structure and evolution of the M87 jet, with telescopes A, B, F, G, H, Jb, Km, Lb, O, N, So, Wn, and Yn.
H-33V	Hough, D. (JPL) Readhead, A. (Caltech)	Pilot survey at 2.8 cm of central components in double-lobed quasars, with telescopes B, F, G, Km, Lm, and O.

No.	Observer(s)	Program
H-42V	Hooimeyer, J. (Leiden) Barthel, P. (Caltech) Schilizzi, R. (NFRA) Miley, G. (STScI)	Observations at 6 cm of the evolution of the core structure of extended quasars, with telescopes B, F, G, Km, Lm, O, So, Wn, and Yn.
K-20V	Kaufman, P. (Itapetinga Obs.) Abraham, Z. (Itapetinga Obs.) Bakor, U. (Itapetinga Obs.) Cohen, M. (Caltech) Nicolson, G. (Hartebeesthoek) Scalise, E. (Itapetinga Obs.) Schaal, R. (Itapetinga Obs.) Unwin, S. (Caltech) Zensus, A. (Caltech)	Observations at 2.8 and 6 cm of the time evolution of spatial structures in 3C 273 and 3C 279, with telscopes B, E, F, G, H, Jb, Km, Lm, Mb, O, So, Wn, and Z.
L-44V	Lestrade, J-F. (JPL) Mutel, R. (Iowa) Niell, A. (Haystack) Preston, R. (JPL)	Observations at 6 cm of Cyg X1, with telescopes B, G, Km, O, Wn, and Yn.
L-49V	Lestrade, J-F. (JPL) Boloh, R. (JPL) Mutel, R. (Iowa) Niell, A. (Haystack) Preston, R. (JPL)	Observations at 6 cm of 15 RS CVn binaries, with telescopes B, G, Lb, O, 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-88V	Moran, J. (CFA) Downes, D. (IRAM) Genzel, R. (Berkeley) Greenhill, L. (CFA) Gwinn, C. (CFA) Hirabayashi, H. (NRO) Reid, M. (CFA)	Observations at 22.235 GHz of M33 to determine the statistical and orbital parallax of H_2O masers, with telescopes B, G, Km, Ma, O, and Yn.
M-95V	Moran, J. (CFA) Baan, W. (Arecibo) Greenhill, L. (CFA) Gwinn, C. (CFA) Haschick, A. (Haystack) Hirabayashi, H. (NRO) Reid, M. (CFA)	Observations at 1.3 cm of th enuclear H_2O maser in NGC 3079, with telescopes B, G, Km, Ma, O, and Yn.

No.	Observer(s)	Program
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, F, G, H, Km, Lm, and O.
P-80V	Pauliny-Toth, I. (MPIR, Bonn) Zensus, A. (Caltech)	Observations at 6 cm of PKS 2134+004 with telescopes B, F, G, H, Km, Lm, O, and So.
R-42V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Cawthorne, T. (Brandeis) Gabuzda, D. (Brandeis) Wardle, J. (Brandeis)	Monitoring at 6 cm of the superluminal sources 3C 120, 3C 273 and 3C 345, with telescopes B, F, G, H, Km, Lm, O, Wn, and Yn.
S-77V	Simon, R. (NRL) Dennison, B. (VPI & SU) Fiedler, R. (NRL) Johnston, K. (NRL) Phillips, R. (Haystasck) Spencer, J. (NRL) Waltman, E. (NRL)	Observations at 6 cm of the possible scattering by the ISM in 0954+658, 1502+106, and 1749+096, with telescopes B, F, G, H, I, Km, N, O, and Yn.
U-17V	Unwin, S. (Caltech) Zensus, A. (Caltech)	Observations at 1.3 cm of 3C 279 during its new flaring phase, with telescopes B, G, Jb, Km, Lm, N, O, Sn, and Yn.
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, Jb, Km, N, O, So, Wn, and Yn.
W-46V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Hummel, E. (MPIR, Bonn) Johnston, K. (NRL) Krichbaum, T. (MPIR, Bonn) Simon, R. (NRL)	Observations at 1.3 cm of the sub-milliarsecond structure of 1803+784, with telescopes B, F, G, H, Jb, Km, Lm, N, O, Sn, and Yn.
X-54V	Hewitt, J. (Haystack) Lonsdale, C. (Haystack) Niell, A. (Haystack)	Attempt at 6 cm to detect α Aqr, with telescopes G and Yn.
Z-17V	Zensus, A. (Caltech) Cohen, M. (Caltech) Unwin, S. (Caltech) Wehrle, A. (Caltech)	Monitor of the superluminal motion in 3C 345 at 1.3, 2.8, and 6 cm with telescopes B, G, H, Jb, Km, Lm, N, O, R, Sn, T, Wn, and Yn.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observers(s)	Program
D-155	Dennison, B. (VPI & SU) Fiedler, R. (NRL) Johnston, K. (NRL) Simon, R. (NRL)	A patrol survey at 2.7 GHz for occultation events.
D-161	Dulk, G. (Colorado) Large, M. (Sydney) McKean, M. (Colorado) Orall, F. (Hawaii) Rottman, G. (Colorado) Bastian, T.	Observations at 20 cm of the solar transition region and corona.

The following line program was conducted during this quarter.

No.	Observer(s)	Program
T-241	Tifft, W. (Arizona)	Observations of HI to study dynamics in diffuse galaxy groups.

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

No.	Observer(s)	Program
B-454	Bowyer, S. (Berkeley) Backer, D. (Berkeley) Clifton, T. (Smith Assoc.,UK) Kulkarni, S. (Caltech) Werthimer, D. (Berkeley)	Observations for narrow-band radio signals of extra-terrestrial origin simultaneous with other programs.

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
A-87	Adler, D. (Virginia) Liszt, H. Roberts, W. (Virginia)	Study of the distribution of molecular clouds in spiral galaxies.
B-495	Bishop, I. (Kent, UK) MacDonald, G. (Kent, UK)	Probing the high excitation cores of G10.6 and G34.3 using methyl cyanide as a molecular probe.

No.	Observer(s)	Programs
B-496	Blitz, L. (Maryland) Desert, X. (Goddard) Bazell, D. (Applied Research) Verter, F. (Goddard)	Study of CO in high galactic latitude regions of excess 100 micron flux.
B-499	Blitz, L. (Maryland) Lehnert, M. (Maryland) Long, K. (Maryland)	Study of clump substructure in molecular clouds.
B-504	Bregman, J. Roberts, M. Hogg, D.	Search for J=2-1 CO in galactic cooling flows.
G-299	Gordon, M.	Maps of the rho Ophiucus dark cloud at 1.3 mm.
H-239	Huggins, P. (New York) Healy, A. (New York)	Study of CO in planetary nebulae.
H-245	Hawkins, I. (Berkeley) Wright, E. (UCLA)	Study of $^{12}C/^{13}C$ from high sensitivity observations of interstellar CN.
J-120	Jewell, P. Hollis, J. M. (Goddard) Lovas, F. (NBS, Maryland) Snyder, L. (Illinois)	A spectral band-scan of the 870 micron window.
K-308	Kaiser, M. (UCLA) Wright, E. (UCLA)	Cosmologic observations of CN at 113 GHz and 227 GHz.
K-310	Koo, B-C. (Berkeley) Heiles, C. (Berkeley)	CO (J=2-1) study of neutral stellar winds in HH7-11.
L-219	Lada, C. (Arizona)	Study of molecular clouds in M31.
L-222	Lada, C. (Arizona) Margulis, M. (Massachusetts)	Observation of emission from highest velocity gas in Monoceros outflow.
L-226	Loushin, R. (Illinois) Crutcher, R. (Illinois) Bieging, J. (Berkeley)	HCO^+ and CS observations toward S106.
M-274	Magnani, L. (NRL) Schwartz, P. (NRL) Blitz, L. (Maryland) Kassim, N. (NRL) Nath, B. (Maryland)	Study of CO outflows in the high-latitude molecular clouds.

No.	Observer(s)	Program
M-278	Martin, R. (Arizona) Ho, P. (Harvard) Turner, J. (UCLA)	Study of CO J=3-2 emission from HII regions in nearby spiral galaxies.
S-315	Stacey, G. (Berkeley) Lugten, J. (Hawaii) Townes, C. (Berkeley) Genzel, R. (MPIR, Bonn)	CO 2-1 observations of gas-rich galaxies.
T-237	Turner, B. Steimle, T. (Arizona State)	Search for CaOH in circumstellar envelopes.
T-238	Turner, J. (UCLA) Ho, P. (Harvard) Martin, R. (Arizona)	J=3-2 CO study of hot gas in extra-galactic nuclei.
T-239	Turner, B.	A search for vibrationally-excited masers in CIT-6.
W-234	Wootten, H. A. Loren, R. (Texas)	SO_2 cores in the rho Oph cloud: Harbingers of star formation?
W-235	Walker, C. (Arizona) Lada, C. (Arizona) Young, E. (Arizona)	Study of 1.3 mm thermal dust emission in cold molecular cloud cores.
W-240	Walker, C. (Arizona) Lada, C. (Arizona) Young, E. (Arizona) Maloney, P. (Arizona)	Test of infall model suggested for IRAS 16293-2422 per CS J=7-6 line.
W-241	Wilking, B. (Missouri) Mundy, L. (Caltech) Howe, J. (Texas) Blackwell, J. (British Columbia)	Study of new molecular outflows toward cold IRAS sources.
W-243	Wootten, H. A.	Study of enhanced ionization near supernova remnant-impacted clouds.
W-245	Wootten, H. A. Combes, F. (Meudon) Encrenaz, T. (Meudon) Gerin, M. (Meudon) Boulanger, F. (IPAC, Pasadena) Bogey, M. (Lille, France)	Further observations of interstellar H_3O^+: tracing water.

No.	Observer(s)	Program
W-247	Wright, M. (Berkeley) Backer, D. (Berkeley) Plambeck, R. (Berkekey) Carlstrom, J. (Berkeley) Masson, C. (Caltech) Readhead, A. (Caltech) Woody, D. (Caltech) Rogers, A. (Haystack) Moran, J. (CFA) Predmore, C. R. (Massachusetts) Dickman, R. (Massachusetts) Emerson, D. Payne, J. Baath, L. (Chalmers) Ronnang, B. (Chalmers) Morimoto, M. (Nobeyama) Hirabayashi, H. (Nobeyama) Meixner, M. (Berkeley)	3 mm VLBI observations.
W-249	Wootten, H. A.	Study of HCO^+ in Cep A and Rho Oph.
W-250	Walker, C. (Arizona) Martin, R. (Arizona)	A CO J=3-2 study of infrared bright galaxies.
Z-64	Ziurys, L. (Massachusetts) Blake, G. (Berkeley)	Confirmation of detection of interstellar vibrationally-excited HCO^+.
Z-67	Ziurys, L. (Massachusetts) Hovde, D. (Berkeley) Saykally, R. (Berkekey)	A search for interstellar SH^+.

E. VLA OBSERVING PROGRAMS

First quarter, 1988 was spent in the following configurations:

B configuration from:	January 01 to February 03
B&C configuration from:	February 03 to March 02
C configuration from:	March 02 to March 31

The following 125 research programs were conducted with the VLA during this quarter.

No.	Observer(s)	Program
AA-79	Apparao, K. (TIFR) Tarafdar, S. (TIFR) Rengarajan, T. (TIFR)	Radio observations of Be stars. 18 cm.

No.	Observer(s)	Program
AA-80	Anantharamaiah, K. Radhakrishnan, V. (Raman) Shukre, C. (Raman)	Positronium towards the galactic center. 6 and 20 cm.
AA-81	Anantharamaiah, K. Radhakrishnan, V. (Raman)	Positronium towards extragalactic objects. 20 cm line.
AA-82	Allen, R. (Illinois) Sukumar, S. (Illinois)	The thin and thick radio continuum disks of NGC 891. 90 cm.
AB-408	Bookbinder, J. (Colorado) Caillault, J. (Colorado) Gary, D. (Caltech) Giampapa, M. (NSO) Golub, L. (SAO) Linsky, J. (Colorado) Gibson, D. (MIT, Lincoln Labs)	First epoch, volume-limited, multi-frequency survey of M dwarf stars. 1.3, 2, 6 and 20 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio 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 Cassiopeia A. 2, 6 and 20 cm.
AB-456	Burke, B. (MIT) Hewitt, J. (Haystack) Roberts, D. (Brandeis)	Time variation of 0957+561 A,B. 6 cm.
AB-459	Baan, W. (Arecibo) Goss, W. M. Gusten, R. (MPIR, Bonn) Haschick, A. (Haystack)	Formaldehyde absorption in NGC 3628. 6 cm line.
AB-462	Bandiera, R. (Arcetri) Brinks, E. (RGO)	The optical knot in Kepler's SNR. 6 cm.
AB-463	Brinks, E. (RGO) Pagel, B. (RGO) Terlevich, R. (RGO)	High resolution HI observations of NGC 5253 and NGC 5408. 20 cm line.
AB-464	Bally, J. (Bell Labs) Yusef-Zadeh, F. (Goddard)	Cometary source G359.2-0. 6 and 20 cm.
AB-465	Bally, J. (Bell Labs) Forrest, W. (Rochester) Fulbright, H. (Rochester)	HI in high velocity bipolar flows. 20 cm line.

No.	Observer(s)	Program
AB-473	Burns, J. (New Mexico) Gisler, G. (LANL) Borovsky, J. (LANL) Baker, D. (Goddard) Zeilik, M. (New Mexico)	Mercury. 2 and 6 cm.
AB-479	Bastian, T. Bookbinder, J. (Colorado) Dulk, G. (Colorado) McKean, M. (Colorado) Taylor, A. (Calgary) Wade, R. (Arizona)	Stellar candidates in a 1.4 GHz survey field. 2, 3 and 6 cm.
AB-481	Bietenholz, M. (Toronto) Kronberg, P. (Toronto)	High resolution studies of the Crab nebula. 6 and 20 cm.
AB-484	Brown, A. (Colorado) Linsky, J. (Colorado) Butler, J. (Armagh Obs.) Bromage, G. (Rutherford Appleton Lab)	The flare star eclipsing binary YY Gem, in support of a coordinated multi-spectral-region observing campaign. 6 and 20 cm.
AC-187	Campbell, B. (New Mexico) Simon, M. (Stony Brook)	High resolution studies of outflow young stellar objects. 2 cm.
AC-205	Condon, J. Helou, G. (IPAC) Sanders, D. (Caltech) Soifer, B. (Caltech)	IRAS bright galaxy sample. 20 cm.
AC-206	Chanmugam, G. (Louisiana State) Dulk, G. (Colorado) Bastian, T.	Magnetic cataclysmic variable stars. 2, 3 and 6 cm.
AC-208	Caganoff, S. (Mt. Stromlo) Bicknell, G. (Mt. Stromlo) Ekers, R.	Southern radio galaxies. 6 cm.
AC-214	Churchwell, E. (Wisconsin) Fukui, Y. (Nagoya) Wood, D. (Wisconsin) Mizuno, A. (Nagoya) Iwata, T. (Nagoya)	Survey of 18 new CO outflow regions. 2, 6, and 21 cm line.
AC-216	Campbell, B. (New Mexico) Asbell, J. (New Mexico)	Search for radio emission from new, young, stellar objects. 6 cm.

No.	Observer(s)	Program
AC-217	Carilli, C. van Gorkom, J. (NRAO/Columbia) Stocke, J. (Colorado)	Search for HI absorption in intervening galaxies towards PKS 0440-209 and 1327-206. 20 cm line.
AC-218	Crampton, D. (DAO) Cowley, A. (Arizona State)	A close pair of quasars. 1.3, 2, 6, 20, and 90 cm.
AD-188	Drake, S. (SASC Tech) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in supergiants: Alpha Ori. 2 and 6 cm.
AD-195/ 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 four normal spiral galaxies. 6 cm.
AD-209	Dickel, H. (Illinois) Goss, W. M.	H_2CO absorption and H76α recombination line study of NGC 6334. 2 cm line.
AD-211	Dickey, J. (Minnesota)	21 cm absorption through the disks of nearby spirals. 20 cm line.
AD-213	Dulk, G. (Colorado) McKean, M. (Colorado) Rottman, G. (Colorado) Bastian, T. Orrall, F. (Hawaii) Large, M. (Sydney)	Solar transition region and corona state of the sun near the Phillipine eclipse of March 17. 20 and 90 cm.
AD-221	de Pater, I. (Berkeley) Palmer, P. (Chicago) Snyder, L. (Illinois)	Comet Liller. 18 cm line.
AF-151	Frail, D. (Toronto) Cordes, J. (Cornell) Hankins, T. (Dartmouth) Weisberg, J. (Carleton) Seaquist, E. (Toronto)	Neutral hydrogen absorption measurements of distant pulsars in the inner galaxy. 20 cm line.

No.	Observer(s)	Program
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Royal Observatory) Ade, P. (Queen Mary College) Robson, E. (Lancashire Polytech) Nolt, I. (Oregon) Smith, M. (Royal Observatory)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20, and 90 cm.
AG-163	Goss, W. M. Ekers, R. Sramek, R. Branch, D. (Oklahoma) Cowan, J. (CFA/Oklahoma)	Search for very young supernova remnants in our galaxy. 21 cm line.
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. Conway, R. (NRAL)	Origin of depolarization asymmetry. 2, 6, 18, and 20 cm.
AG-252	Goss, W. M. Viallefond, F. (Meudon) Boulanger, F. (IPAC/Caltech) Peimbert, M. (UNAM)	Radio continuum survey of the spiral M101. 90 cm.
AG-255	Gwinn, C. (SAO) Birkinshaw, M. (Harvard) Fiedler, R. (NRL) Dennison, B. (NRL) Simon, R. (NRL)	Search for host structures of extreme scattering events. 6 cm.
AG-258	Garay, G. (Chile) Rodriguez, L. (UNAM)	The exciting stars of IRAS compact HII regions. 2, 6, and 20 cm.
AH-254	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Radio observations of 3 pre-1987 and bright 1987 novae to complement extensive infrared observations. 1.3, 2, 6, and 20 cm.
AH-293	Hanisch, R. (STScI) Miley, G. (STScI)	The rich X-ray cluster Abell 2256. 20 and 90 cm.
AH-295	Habing, H. (Leiden) Goss, W. M. Winnberg, A. (Onsala) van Langevelde, H. (Leiden)	Monitoring galactic center OH/IR stars. 18 cm line.

No.	Observer(s)	Program
AH-297	Harvey, P. (Texas) Forveille, T. (Grenoble)	The compact HII region W28A2. 1.3, 2 and 6 cm.
AH-298	te Lintel Hekkert, P. (Leiden) Zijlstra, A. (Leiden) Pottasch, S. (Kapteyn Lab) Caswell, J. (CSIRO) Habing, H. (Leiden)	OH in very young planetaries and irregular OH/IR stars. 18 cm line.
AH-299	Helfand, D. (Columbia) Becker, R. (Calif., Davis)	A 327 MHz survey of the galactic plane. 90 cm.
AH-300	Helfand, D. (Columbia) Hamilton, T. (SAO)	In search of the origin of the X-ray background. 20 cm.
AH-301	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Systematic observations of two new radio novae. 1.3, 2, 3.6, 6, and 20 cm.
AH-303/ AH-304	Higdon, J. (Texas)	Continuum and neutral hydrogen observations of ring galaxies: the cartwheel. 6 and 20 cm line.
AH-305	Ho, P. (Harvard) Szczepanski, J. (MIT) Pyne, E. (Harvard) Jackson, J. (Calif., Berkeley) Armstrong, J. T. (Cologne)	NH_3 condensations in the neutral ring around the galactic center. 1.3 cm line.
AJ-156	Jaffe, W. (Leiden) Hoessel, J. (Wisconsin) Oke, J. (Caltech)	Medium deep optical/radio survey. 20 cm.
AJ-160	Joshi, M. (TIFR) Bagchi, J. (TIFR) Kapahi, V. (TIFR)	Spectral index mapping of very steep spectrum sources in clusters. 90 cm.
AK-184	Kazes, I. (Meudon) Mirabel, I. F. (IAPE, Argentina) Dickey, J. (Minnesota)	Continuum observations of two megamaser galaxies. 2, 6, and 20 cm.
AK-186	Keto, E. (Lawrence Livermore Lab) Garay, G. (Santiago) Ho, P. (Harvard) Reid, M. (CFA)	Defining the collapsing core of G34.3+0.2 at 0.4". 1.3 cm line.

No.	Observer(s)	Program
AK-192	Katgert, P. (Leiden) Oort, M. (Leiden)	Redshift- and luminosity-dependence of linear radio sizes of ellipticals. 20 cm.
AK-194	Kundu, M. (Maryland) Agrawal, P. (MSFC) White, S. (Maryland)	Microwave observations of certain X-ray emitting dM flare stars. 6, 20 and 90 cm.
AK-195	Kutner, M. (RPI) Mundy, L. (Caltech)	Dynamics of G10.6-0.4: testing a model of massive star formation. 2 cm line.
AL-146	Leahy, J. Perley, R.	Bridges in nearby 3C sources. 20 cm.
AL-150	Lestrade, J-P. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.
AL-156	Lind, K. van Breugel, W. (Berkeley)	Further observations of edge-brightened jet in PKS 0623-206. 6 cm.
AL-162	Lazio, J. (Iowa) Spangler, S. (Iowa) Cordes, J. (Cornell)	Studies of rotation measure fluctuations in the Cygnus region. 20 cm.
AL-167	Lewis, B. (Arecibo) Schmelz, J. (Goddard) Terzian, Y. (Cornell)	Accurate positions for new 1612 MHz OH maser sources. 18 cm line.
AL-173	Linfield, R. (JPL)	Radio sources for planetary occultations. 3.7 cm.
AM-217	Morris, D. (Iowa) Mutel, R. (Iowa)	Investigation of radio emission in RS CVn binaries and comparable single stars. 6 cm.
AM-226	Muhleman, D. (Caltech) Berge, G. (Caltech) Hofstadter, M. (Caltech)	Uranus. 2, 6, and 18 cm.
AM-227	Maccacaro, T. (CFA) Gioia, I. (CFA) Wolter, A. (CFA) Stocke, J. (Colorado) Morris, S. (Mt. Wilson)	Radio observations of the extra-galactic component of the Einstein medium sensitivity survey: an extension to the south. 6 cm.

No.	Observer(s)	Program
AM-229	Menten, K. (MPIR, Bonn/SAO) Johnston, K. (NRL) Wilson, T. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	Methanol absorption in W3(OH). 1.3 cm line.
AM-230	Mundy, L. (Caltech) Kutner, M. (RPI)	Study of a possible circumstellar disk in GL 490. 2 cm line.
AM-231	Morris, M. (UCLA) Omont, A. (Grenoble) Likkel, L. (UCLA) Forveille, T. (Grenoble)	Is IRAS 21282+5050 a pre-planetary nebula? 2 and 6 cm.
AO-76	O'Dea, C. (NFRA) Gregorini, L. (Bologna) Feretti, L. (Bologna) Giovannini, G. (Bologna)	Complex radio emission in Abell 568. 6 cm.
AO-80	Owen, F. Perley, R.	Observations of B3 classical doubles. 6 cm.
AP-135	Perley, R.	Rotation measure of 3C 295. 2 cm.
AP-152	Preston, R. (JPL) Purcell, G. (JPL) Ulvestad, J. (JPL) Jones, D. (JPL) Linfield, R. (JPL)	Phobos lander VLBI reference sources. 6 cm.
AP-153	Pooley, G. (MRAO) Alexander, P. (MRAO)	Circum-nuclear star formation in ultra-luminous galaxies. 2, 6, and 20 cm.
AP-159	Penninx, W. (MIT) Lewin, W. (MIT) Mitsuda, K. (ISAS) van Paradijs, J. (Amsterdam) Zijlstra, A. (Groningen)	Simultaneous radio and X-ray observations of the low-mass X-ray binary GX 17+2. 6 and 20 cm.
AR-165	Rupen, M. (Princeton) Condon, J.	A systematic search for radio supernova in nearby galaxies. 6 cm.
AR-166	Roser, H. (MPIA, Heidelberg) Perley, R. Meisenheimer, K. (MPIA, Heidelberg)	Hotspots, jet, and lobes of Pictor A. 90 cm.
AR-168	Rusk, R. (Toronto)	Radio polarimetry of 1807+698 (3C 371). 6 and 18 cm.

No.	Observer(s)	Program
AR-170	Rodriguez, L. (UNAM) Roth, M. (UNAM) Tapia, M. (UNAM) Persi, P. (IAS) Ferrari-Toniolo, M. (IAS)	Spectral index of Cyg OB2 No. 5. 1.3, 2, 6, and 20 cm.
AR-172	Reich, W. (MPIR, Bonn) Handa, T. (NRO) Furst, E. (MPIR, Bonn) Sofue, Y. (Univ. Tokyo) Reich, P. (MPIR, Bonn)	Search for plerionic or combined-type supernova remnants. 6 and 20 cm.
AR-173	Richards, P. (Rutherford Appleton Lab) Heaton, B. (Kent)	Ionized gas associated with compact molecular clouds detected by IRAS. 6 and 20 cm.
AR-175	Richter, O. (STScI) van Gorkom, J. (NRAO/Columbia) Ferguson, J. (Johns Hopkins)	The HI content of NGC 3312. 20 cm line.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Supernovae SN1980 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)	Statistical properties of radio supernovae. 2, 6, and 20 cm.
AS-300	Siemieniec, G. (MPIR, Bonn) Urbanik, M. (Krakow) Beck, R. (MPIR, Bonn) Hummel, E. (NRAL)	The radio disks of NGC 891 and NGC 3628. 20 cm.
AS-306	Sukumar, S. (Illinois) Cowsik, R. (Washington U-St Louis) Allen, R. (Illinois)	High resolution study of a double-lobed X-ray source. 6, 20, and 90 cm.
AS-309	Sumi, D. (Caltech) Norman, M. (Illinois) Smarr, L. (Illinois)	Survey of the radio structure of cooling inflow galaxies. 2, 6, and 20 cm.
AS-314	Saikia, D. (NRAL) Yates, G. (NRAL) Pedlar, A. (NRAL) Axon, D. (NRAL) Unger, S. (RGO)	Sersic-Pastoriza galaxies: a link between Seyfert and starburst galaxies? 6 cm.
AS-325	Sukumar, S. (Illinois) Allen, R. (Illinois)	NGC 5236 (M83). 20 and 90 cm.

No.	Observer(s)	Program
AS-326	Sukumar, S. (Illinois) Allen, R. (Illinois)	Edge on galaxy NGC 4565. 20 and 90 cm.
AT-89	Torres, A. (Goddard) Gull, T. (Goddard) Hollis, J. M. (Goddard) Yusef-Zadeh, F. (Goddard)	The Hourglass in M8. 6 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-151	van Gorkom, J. (NRAO/Columbia) Knapp, G. (Princeton) Ekers, R.	A search for atomic and molecular gas in elliptical radio galaxies. 6 cm line.
AV-153	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Spinrad, H. (Berkeley)	High redshift radio galaxies with extended optical line emission. 2 and 6 cm.
AV-154	Viallefond, F. Zheng, X. (CFA)	Low frequency survey of the sources in the spiral M33 and large scale disk emission. 90 cm line.
AV-155	Venugopal, V. (TIFR) Bhatt, H. (TIFR)	1912+172 PO9 - Planetary nebula? 1.3, 2, 6 and 20 cm.
AW-169	Winglee, R. (Colorado) Dulk, G. (Colorado) McKean, M. (Colorado)	Substellar and planet-like companions of nearby stars. 20 and 90 cm.
AW-173	Wilking, B. (Missouri) Mundy, L. (Caltech) Howe, J. (Texas)	Cold IRAS sources. 2 and 6 cm.
AW-198	Willson, R. (Tufts) Lang, K. (Tufts)	Dynamic spectra of microwave bursts from active stars. 20 cm line.
AW-199	Willson, R. (Tufts) Lang, K. (Tufts)	Survey of active cool stars. 6 cm.
AW-200	Willson, R. (Tufts) Lang, K. (Tufts)	Spectra of active cool stars. 2, 6, and 20 cm.
AW-202	Wrobel, J. (NMIMT) Heeschen, D.	Survey of a volume-limited sample of E/SO galaxies: spectral indices between 6 and 20. 20 cm.

No.	Observer(s)	Program
AW-203	Wilson, T. (MPIR, Bonn) Johnston, K. (NRL) Pauls, T. (NRL) Walmsley, C. M. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	Distribution and kinetic temperature of OH in W3 (OH). 1.3 cm line.
AY-22	Yun, M. (Harvard) Ho, P. (Harvard) Lo, K. (Illinois)	HI synthesis mapping of M82. 21 cm line.
AZ-31	Zhao, J. (New Mexico) Burns, J. (New Mexico) Owen, F.	Turbulent radio jets in cluster galaxies. 6 and 20 cm.
AZ-34	Zirin, H. (Caltech) Gary, D. (Caltech)	High-resolution studies of the quiet sun. 6 cm.
AZ-35	Zheng, X. (Nanjing) Reid, M. (CFA) Birkinshaw, M. (Harvard) Ho, P. (Harvard)	The low frequency characteristics of NGC 6251. 90 cm line.
VAH-35	Phillips, R. (Haystack)	Non-thermal radiation from Ap and Bp stars. 6 cm phased array MK III VLB.
VAH-36	Niell, A. (Haystack) Cappallo, R. (Haystack) Hewitt, J. (Haystack) Lonsdale, C. (Haystack) Phillips, R. (Haystack)	AE Aquarii. 6 cm phased array MK III VLB.

F. SCIENTIFIC HIGHLIGHTS

Mira's Circumstellar HI

High-sensitivity 21 cm VLA observations of Mira (σ Cet) have resulted in the detection of HI in its circumstellar envelope. This is only the second such detection of HI from the wind of an evolved mass-losing cool giant star, following the detection of HI in the envelope of Betelgeuse (α Ori) and in material around some planetary nebulae. The shell expansion velocity and the systemic velocity are in excellent agreement with existing values from CO observations. Unlike the molecular measurements, which are affected by interstellar uv photo dissociation, however, the HI emission can provide reasonably reliable values of the mass-loss rate, the total envelope mass, and the envelope extent. For Mira, at a distance of 77 pc, and unconfused by background galactic HI, the envelope radius is 1.8×10^{17} cm, the crossing time

(age) is 1.3×10^4 yrs, and the total HI mass is 6×10^{-4} $M_\odot$. The roughly spherically symmetric shell is approximately one-third atomic as it leaves the star.

Investigators: P. Bowers (Sachs/Freeman), G. Knapp (Princeton)

Kiloparsec Scale Superluminal Motion in 3C 120

Second epoch VLA measurements of a knot in the 3C 120 radio jet give a preliminary indication that the knot is moving outward from the core with an apparent linear velocity of 3.7 times the speed of light. Extremely high dynamic range observations at 5 GHz in the A configuration were obtained in 1983 and 1987 and employed in a very sophisticated technique in which one u-v data set was subtracted from the other in order to minimize deconvolution errors. A difference map of the two data sets shows that the knot has moved away from the core by 9 ± 3 milliarcseconds between epochs. VLBI measurements within a few parsecs of the core have previously established superluminal motions for 3C 120. The new VLA measurements offer the first evidence, however, that the superluminal motions extended well outward in the jet. These measurements, together with observations of large scale jet one-sidedness and depolarization asymmetries considerably strengthen arguments that relativistic motions in jets exist to a considerable distance from the core.

Investigators: R. C. Walker (NRAO), M. A. Walker (Penn State), J. Benson (NRAO)

C_3H_2 Emission in Centaurus A

Broad, weak emission in the 1_{10}-1_{01} transition of the hydrocarbon ring molecule C_3H_2 has been detected in the nuclear region of the radio galaxy Centaurus A with the 140-ft telescope. HI and several molecular species such as OH, H_2O, and C_3H_2 had previously been detected in absorption against the small but relatively powerful nuclear radio source, but only HI has been seen in emission. This is the sixth instance where molecules in external galaxies have been detected through their thermal emission. The previous detections have been CO, NH_3, CS, HCN, and HCO^+. Each of four positions located along the dust lane straddling the nucleus shows only a slight indication of C_3H_2 emission. The average spectrum, however, shows clear evidence for broad emission centered on the systemic velocity of the galaxy. The observations are consistent with the presence of C_3H_2 uniformly distributed in a rigid rotating nuclear disk about 4 kpc in radius.

Investigators: M. Bell (Herzberg Institute), E. Seaquist (Toronto)

Investigation of Diffuse Molecular Clouds

The 12-m telescope has been used to survey a new catalogue of high galactic latitude sources which contain IRAS 100 μm emission in excess of the amount expected from HI-100 μmcorrelations. Although the objects are likely to be molecular clouds, the search for CO has strong implications for understanding the local interstellar medium. So far, the observations indicate that CO is not detectable in the clouds above a certain cutoff level in the value of the 100 μ

excess. Apparently the clouds have properties that are dissimilar to Giant Molecular Clouds. They appear to be more diffuse, lower in density, and to have a CO/H_2 ratio more than an order of magnitude lower than that of GMCs. A search for the presence of lower density molecular tracers such as CH will be carried out.

Investigators: L. Blitz (Maryland), X. Desert (GSFC), D. Bazell, F. Verter (Applied Research Corporation)

G. PUBLICATIONS

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

H. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

The final Voyager receiver was shipped to the VLA site during this quarter. Receiver #9 has been repaired and returned to the VLA.

Receivers #18 and #24 have been returned to Charlottesville for repair. We propose, in the future, to repair receivers at the VLA site; only the HEMT amplifiers will be returned for repair.

The technician responsible for building the 30 Voyager receivers will spend a week at the VLA site later this year to assist with the repair of receivers that may fail in the next few months.

So far the few failures have resulted from a variety of causes. No particular trend requiring further attention has yet been identified. There has been one HEMT failure due to a broken bond wire.

L-Band Cooled HEMT Amplifier Development

A program to retrofit old GaAsFET cooled amplifiers with HEMT's has begun. The first four are ready for use in Green Bank and should result in about a 5 K system temperature improvement of the L-band receiver. After building some amplifiers for new projects and spares, all eight of the IF amplifiers from the Tucson eight-feed receiver will be retrofitted.

15 GHz Cooled HEMT Amplifier Development

The design of the VLBA 15 GHz HEMT amplifier was finalized during this quarter. Eight units have been built and tested. Noise temperature is typically 18 K over the frequency range 14.3-15.6 GHz. Six of these units were installed in the 15 GHz VLBA receiver #1 and in two M.I.T. copies of a VLBA receiver. These receivers were used for a successful VLBI experiment between a synchronous satellite (TDRSS) and ground antennas in Japan and Australia.

Two units have been sent to the VLA to replace a pair of cooled GaAsFET amplifiers on one of the antennas that is still to be upgraded. The system temperatures will be improved somewhat in the band center and significantly at the band edges at 14.4 and 15.4 GHz.

23 GHz Cooled HEMT Amplifier Development

Forty-two amplifiers have now been built. During this quarter we have evaluated two Mitsubishi 0.3 μm HEMT's, and they were found to have excellent performance. They gave average noise temperatures of 55 K over the 22-25 GHz frequency range. Only a few GE HEMT's have given better performance.

We plan to buy more devices to use in amplifiers for the VLA and VLBA that will be built during the rest of this year.

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.

During this quarter the following progress has been made:

1. A room temperature, single-stage amplifier giving 300 K noise and 6 dB gain has been constructed. This amplifier utilizes a GE HEMT that is not suitable for cooling.

2. At a meeting with representatives from GE and JPL on February 24, it was agreed that some samples of new HEMT's would be supplied to NRAO by June of 1988. These new devices are expected to have excellent cryogenic performance at 43 GHz.

3. Work has continued on the modeling and calibration of a test fixture to measure transistor noise parameters.

Superconducting (SIS) Millimeter-Wave Mixer Development

Our millimeter wave research collaboration with IBM Watson Research Center is continuing. A new set of new SIS mixers for 115 and 230 GHz have 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 the high input loss of the telescope receiver, its noise temperature is relatively high: 74 K to 138 K SSB in the better channel, and about 20 K higher in the other channel.

The $Nb/Al\text{-}Al_2O_3/Nb$ trilayer process for fabricating superconducting circuits appears to be the best available for millimeter-wave SIS mixers. This process, originally developed at Bell Labs and now in use at Hypres Inc., is

being implemented at UVA as part of a collaborative effort with NRAO to develop better SIS mixers. 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.

We are also continuing our collaboration with Hypres Inc. We have designed new mixers for 115 GHz and 230 GHz which will be fabricated using their Nb/Al-Al_2O_3/Nb trilayer process. The seven masks for this process were laid out using UVA mask design facilities. We expect to have the first devices soon.

Schottky Diode Millimeter-Wave Mixer Development

In support of the 12-m telescope this quarter, we have tested a total of 46 Schottky mixers in the 230, 300, and 345 GHz bands. Within each band, and for a given diode type, the mixer noise temperatures vary over a 3:1 range. We have found a strong correlation between certain low frequency noise characteristics of the diodes and their mixer characteristics. However, as it is necessary to go through the complete mixer assembly process and cool the mixer before we can obtain the low frequency noise information, this knowledge does help our yield of acceptable mixers greatly.

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.

I. GREEN BANK ELECTRONICS

300-ft Spectral Processor

The Spectral Processor project continues. The eleven FFT boards needed for the first phase of the assembly work have been built, and seven have been tested and debugged. A board that controls the FFT boards, counts the total power, and counts the LO frequencies has been built, and is ready for testing. Design work for the digital card for the IF processor modules has started.

Work continues on the Accumulator, consisting of two memory cards and two controller cards. The memory card design has been finalized and the second unit awaits tests. The first controller card is now being tested, and the second must be designed.

Assembly of the digital racks continues. The wirelist for the rack backplane was completed this quarter, and the backplane wiring is one-third done. Work continued on the system software.

Work on the IF/Video converters continued. The interference detector circuit was designed and built. This detects a total-power signal above a level set by the observer, and generates a signal that is used to reject data observed during that period. The low-resolution synthesizer (185-660 MHz, 10 kHz

resolution) design was completed. Testing continued on the single-sideband network. Sideband rejection is better than 36 dB up to 2 MHz, and the worst-case rejection is about 28 dB at 40 MHz. A revised layout is planned to improve the phase match at the higher frequencies. Work began on an IF distribution system that will be needed at the 300-ft when the Spectral Processor comes on-line.

Adaptive Array Receiver

The Adaptive Array Receiver project is designed to develop a receiver to increase the 300-ft antenna off-axis beam efficiency by synthesizing a clean beam using an array of feeds. This quarter it was determined that the staggered array of cavity backed dipoles would not produce a sharply focused main beam. Other feed elements and array configurations are being considered by the staff and associates at the University of Virginia.

Because of the shortage of Research Equipment funding and because the project personnel have been shifted to work on the Green Bank Interferometer upgrade, this project will be significantly delayed. Work will continue on the feed and array design, but most further construction will be delayed at least until the end of the year.

Local Area Network

During the past year, a plan has been developed to improve the computing environment at Green Bank and to allow gradual upgrades of the computing hardware. The backbone of this plan is a high-speed local area network that will interconnect all telescopes, the Jansky Lab, and other on-site buildings. The goal is to store acquired telescope data so that is can be quickly accessed from any node on the LAN and to allow more efficient and cost-effective use of our resources.

The LAN is implemented as a Ethernet with interconnecting fiber-optic cables running throughout the site. During this quarter, all of the fiber-optic cable was installed, and data communications were established between the 300-ft control computer and the Jansky Lab. Two Sun 3/60 workstations were received, and one was installed on the network at the 300-ft. Work began on interfacing the second Sun to the 140-ft control Modcomp. These workstations will become the primary data analysis computers when analysis software is ported to them.

Continued work is required to investigate some reliability problems with the LAN. Occasional lock-ups have occurred, and we are attempting to isolate the source of the problems. Some of the optical transceivers were returned to the manufacturer due to out-of-spec performance.

Miscellaneous

The design of a cooled 2.3 GHz HEMT amplifier was completed this quarter, and two units were installed in the first VLBA 2.3 GHz front-end. These amplifiers have noise temperatures under 7 K from 2.0 to 2.5 GHz, integral 30 dB noise-cal couplers, and input return loss better than 12 dB.

Six 4.8 GHz cooled HEMT amplifiers were produced. Time was spent evaluating HEMT devices as a great deal of variation has been observed from transistor lot to lot. A good batch of Mitsubishi HEMT devices was tested, yielding noise temperatures under 4 K in a three-stage amplifier, but additional devices from that lot are evidently not available. The search for a reliable supply of HEMT devices will continue, in cooperation with the CDL.

Testing was completed on three VLBA receivers, and construction began on the units required this year. Ten 2-16 GHz VLBA synthesizers scheduled for completion this year are under construction.

J. 12-M ELECTRONICS

70-115 GHz Schottky Mixer Receiver

The 70-115 GHz Schottky dual-channel receiver remains unchanged since the last quarterly report. It is the only receiver to cover the 70-90 GHz spectral line band and is also used for continuum observations at 90 GHz.

200-350 GHz Schottky Mixer Receiver

The 200-350 GHz Schottky dual-channel receiver has been used over the full frequency range during this quarter. Efforts are currently underway to improve the performance over the 240-270 GHz range.

90-115 GHz SIS Receiver

The 90-115 GHz SIS receiver has been in routine use during the last quarter. The hold time on the cryostat has been improved and now a helium fill is required twice per week. Noise temperatures of around 100 K SSB are obtained across the frequency range.

Multi-feed 230 GHz Receiver

The multi-feed 230 GHz receiver was tested on the telescope in December 1987 and performed well. Work during the past quarter has been directed towards completing the control circuits and interface electronics for the receiver. The receiver will be made available to observers in the fall.

Hybrid Spectrometer

Work continues on the hybrid spectrometer. We are aiming at telescope tests in the fall.

VLBA Receiver

We have completed a room-temperature receiver for evaluating the VLBA antennas at 87 GHz. This receiver will be installed on the VLBA antenna in the next few months.

K. VLA ELECTRONICS

Improvements In Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam, and pointing errors then limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beam width so the source being imaged is effected directly. For example, at 44 GHz a 20" pointing error causes a 30 percent change in amplitude.

Another pointing problem which will be addressed in the future 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 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 redesigned tilt-meter units showed that the temperature control of the tiltmeter meter unit is now adequate.

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

Two new dipole feeds have been designed; one a crossed dipole type, the other a quad dipole type. The crossed dipole was chosen as the easiest to implement, and testing of this feed and its effect on other frequencies will continue into next quarter. With the new feed installed near the focus of the

antenna, locally generated radio frequency interference became a significant problem (see RFI Improvements). Four antennas are equipped with the 75 MHz system. NRAO has an agreement with NRL for further outfitting. The first level of funding (for four more systems) has been received and components are being procured.

VLA 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 field of view larger than the 30 arcmin 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). Components for the completion of this system are being procured.

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.

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, and antennas being overhauled will be outfitted with X-band feed towers. Installation of the remaining nine X-band systems will continue through 1988.

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 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 half-hour. 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 fifteen 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 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 GB Electronics Division. This dewar assembly, along with a VLBA polarizer, was installed on VLA Antenna 23. Satisfactory testing of the receiver was completed last year. No further investigations are scheduled for this year.

L. AIPS

A variety of improvements and corrections were made to the basic interferometer calibration package. A new task, GETJY, was added to determine the fluxes of secondary calibrators from the existing calibrations. Another new task, FILLM, was written to read data tapes from the new VLA on-line system.

Spectral smoothing was added to all appropriate calibration tasks. TVFLG was improved in its handling of windows and subarrays. A significant effort was also made to improve the performance of the main calibration tasks. Using vectorization of the Convex, improvements of about 30 percent were obtained.

The first release was prepared (for April release) of a vastly improved package of routines for handling single-dish data within AIPS. A task to read and translate tapes in single-dish FITs table format was released. The calibration package was extended to work on single-dish data through new tasks SDCAL and CSCOR. Pointing calibration was added. Many of the regular uv-data programs do function on single-dish data sets. However, their handling of such data could often be improved with some specific effort.

A task called TXPL, submitted by Glen Langston, has been implemented in AIPS. TXPL translates AIPS plot files for printer-like devices, including line printers, terminals, and even the AIPS history file. The development of AIPS on SUN TVs has been enhanced by the loan of a 3/110 from SUN and by the submission of SUN display code by Brian Glendenning. The long-awaited virtual TV in AIPS has been released. This concept and code lets AIPS on one CPU think that it has a TV display, while in fact the real display exists on some other computer down the hall or around the world (but wherever the user is actually located). Tests suggest that, at least for Ethernet local area networks, the response is good enough to be rated "interactive" or better.

A wide variety of corrections to existing code were also made.

M. VLA COMPUTER DIVISION

The new on-line computer system was fully installed at the beginning of the year. The change-over went as planned, and observations after the new year shut-down started on schedule. There were several bugs that were not discovered in the tests last year, and there were a few operational procedures that were not completely implemented. Consequently, there was a small loss of observing time while those problems were being resolved. However, the array down-time due to computer problems in the first two months of operation was less than with the old computers.

The capability of the new on-line system is such that 512 spectral line channels may be produced using all antennas. This is an increase by a factor greater than 17.5 compared to the old system. It is also possible to produce continuum data with an integration time as short as 1.67 seconds, a factor of 4 faster than the old system. Since the image processing computers currently available at NRAO have very little spare capacity processing the data produced by the old system, an administrative limit has been placed upon the amount of data that may be produced by any observation. In special cases, this limit may be relaxed by permission of the director.

The new on-line system produces an archive tape that uses a new format at 6250 bpi. The old tapes were written at 1600 bpi. The program that fills data from the archive tape into the DEC-10 has been enhanced to accept this new format. In order to read all old archive tapes, the old format can still be read

by this program. A new task of AIPS (FILLM) that reads the new archive tapes has been written and has been released to users for testing. Continued support of this program is planned.

The programs that produce images on the pipeline computers have now been completely recast to run on the Convex computer. This package, to be known as the Interactive Spectral-line Imaging System (ISIS), has been partially released for testing. The first full release will comprise only imaging functions and should take place in the second quarter. Calibration functions will be added later.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

At the Pie Town, NM site, monitor and control software development, and remote pointing tests continued. The subreflector and focus/rotation mount installation is scheduled for the week of April 11. Completion of outfitting, and extensive testing and debugging, is scheduled for this site in the months immediately following. Participation in the May - June NUG runs at 6 and 18 cm is tentatively scheduled, together with the first scientific utilization of the VLBA recorder (in MkIIIA mode).

The subreflector passed NRAO acceptance tests at the manufacturer's premises in mid-March, and was shipped to the University of Arizona's Large Optical Generator for high precision measurement of its surface. The subreflector will be forwarded to the VLA shops in early April for outfitting and painting.

At the Kitt Peak, AZ site the initial mechanical, electronics, and cryogenics outfitting have been completed. At the Los Alamos, NM site antenna installation is complete except for punch list items, and the completion of painting and HVAC are scheduled for April. Initial NRAO outfitting at Los Alamos is scheduled to begin in May. At Fort Davis, TX the antenna structure is erected, and main reflector panels are being installed.

The North Liberty, IA and Brewster, WA sites are complete and awaiting antenna installations by RSI. At Owens Valley, construction has begun on the building and antenna foundation, which is now site #7. Saint Croix, VI replaces it as #8 due to the extended site acquisition procedures required. For the Mauna Kea, HI site the first of a sequence of enabling and approval documents have been submitted to local authorities. A decision on the location of the Northeast site is expected in April.

Electronics

The three racks comprising electronics system #4 were completed and tested in January and will be installed on the Los Alamos antenna. System #5 racks have been completed and are awaiting testing. The prototype racks, system #1, were returned to Charlottesville in early March for several modifications. They will

be returned to the electronics laboratory in Socorro for use in diagnostic maintenance of field equipment modules.

The first front-end for the 2.3 GHz band was completed and will be installed on the Pie Town antenna in April. It has a noise temperature of 10 K in the central part of the band. The 23 GHz front-end was also completed. It has a noise temperature of 55-65 K over most of the 21.7-24.1 GHz band. Work is continuing on two prototypes for the 43 GHz band; one using an SIS mixer and the other a HEMT amplifier.

The first dichroic reflector system for the 2.3 and 8.4 GHz bands has been completed and will be installed on the Pie Town antenna in April. Two of the Sigma-Tau hydrogen masers that were received last year are now undergoing intensive testing at the JPL maser laboratory in Pasadena, to obtain an independent evaluation of their performance.

As the quarter closed, preparations were being made to move the VLBA electronics and correlator groups in Charlottesville from the Ivy Road building to the NRAO Edgemont Road building. About three-quarters of one floor at Ivy Road will be vacated, resulting in significant cost savings. The move should be complete by mid-April.

Data Recording

Work continues in Socorro on development of station computer control of the first prototype recorder, formatter, and associated I.F. data processing (DAR) rack. The purchasing, planning, and design for the "preproduction" (#3 and #4) versions of the data acquisition system have started under recent contract additions authorized for Haystack Observatory. Also authorized is the design and construction of the first two playback drives (PBD), which are virtually identical to the recorders except for two electronic boards.

Haystack's second prototype recorder was completed in March and testing initiated. It will remain at Haystack until fall to allow for more complete evaluation; as a test-bed for enhancements; for debug of problems encountered in the field; and cross check playback of tapes recorded at Pie Town. The second prototype formatter is scheduled for completion by April 30. Its electronic boards have been sent to an outside vendor for wire wrapping.

Monitor and Control

During the last quarter, the development of operator interface software programs continued. These programs are now available for essentially all local station functions, although those for the recorders and its formatters are still in preliminary form.

Astronomical observing routines are now logically complete, except for the setup of the tape recorder and formatter. Some of the programs are present in skeleton form only (especially the monitor data checker), but work is progressing on fleshing them out. Pointing parameter estimation programs have been demonstrated, although a certain amount of hand work is still necessary in the process.

Work has begun on a set of programs that will serve to communicate between the station computers and the MicroVax that will serve as the array controller. A set of monitor data handling programs is now present in skeleton, undebugged, form.

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. We expect delivery in April.

Firmware for the focus/rotation controller is essentially complete. A preliminary version of the device is ready for installation at Pie Town. Modest changes are necessary for the final version of the mount.

A utility interface module has been designed to access various test and alarm points not available to other Monitor/Control bus devices, and is being built, as well as a special interface to collect data from tilt and temperature sensors. The latter is complete, while the module is currently being built.

The Pie Town weather station is essentially complete and installed at the site, except for the dewpoint sensor which will be installed in the second quarter.

The Kitt Peak computer system has been installed at the site. The Los Alamos computer is in the final stages of preparation for shipment, and all parts for the Fort Davis computer are in hand.

Correlator

A Request for Proposals was issued for the final design, prototyping, and fabrication of the "FX chip" on which the correlator architecture is based. Proposals were solicited from 15 firms, and will be subject to an evaluation based on cost, proposed technology, technical capability, design center location, and delivery schedule. The breadboard model of the chip logic has been completed and is proving useful in an unintended area: serving to simulate and verify the preliminary layout for the FFT module. Its primary purpose--generation of test vectors for verification of the final design and the prototype chips--is awaiting more detailed information from the selected vendor.

Progress also continued on the playback interface section (PBI), where a painstaking enumeration of all possible modes of the programmable VLBA formatter has been undertaken. The playback interface will probably impose some restrictions on the full generality of the formatter, but care is being exercised to ensure that these will not preclude any scientifically valuable modes. Members of the correlator group participated in a review of the VLBA record/playback system held at Haystack Observatory in January. This meeting ratified the group's proposed partial specification of the VLBA tape format and error-detection/data-editing scheme. Areas of the correlator-playback control interface requiring further development were also identified.

The position of system designer for the correlator's complex computer and software structures was filled by a member of the Observatory staff who has wide-ranging experience in real-time process control, local-area networking, and other relevant fields. At the close of the quarter, preliminary plans for computer

hardware, system substructuring, and interprocess communication are under intensive review. Development of a more detailed design is beginning. It is expected that much of the originally proposed operational configuration will be retained, but significant changes in the development environment may be proposed.

Data Processing

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

(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. Data from the Caltech Block II correlator can now be written in the VLBA distribution format. Data from Haystack should soon be available.

(2) The preliminary design of the calibration software has been done and is being implemented. The continuum calibration routines have been written and are in production use. Development during the last quarter has been in the areas of spectral line and ionospheric calibration. High accuracy geometric models are being considered to improve the accuracy of the calibration.

(3) The concerns of geometric accountability are being included in the design of all software and data structures. We are negotiating to hire an astrometrist to develop the data structures and software needed in this area.

Array Operation Center

The structure is virtually complete, with final external wall surfaces almost complete. Much of the bulk plumbing, electrical, and HVAC equipment are installed. Room partition metal studs are being installed. Occupancy in August or September 1988 is expected.

O. PERSONNEL

New Hires

Tifft, William	Visiting Scientist	01/13/88
Roelfsema, Peter	Research Associate	02/08/88

Terminations

Marymor, Julius	Contracts Manager	01/15/88
Viallefond, Francoise	Visiting Scientist	01/11/88
Keyes, Michael	Chief Accountant, VLA	02/29/88
Garagnon, Bruno	Scientific Prog. Analyst	02/29/88
Sebring, Paul	Asst. to VLBA Project Manager	02/29/88
Hovatter, Donald	Executive Assistant	03/31/88
King, W. Dale	Scientific Prog. Analyst	03/31/88

Promotions

Broadwall, Charles	to Electronics Engineer I	01/01/88
Hill, Ruben	to Electronics Engineer I	01/01/88
Dowd, Andrew	to Electronics Engineer I	03/01/88
Gibb, James	to Fiscal Officer	03/01/88
Ortiz, Nancy	to Chief Accountant	03/01/88

Other

van Gorkom, Jacqueline	Leave of Absence (half time)	01/01/88
Ekers, Ronald	Leave of Absence (two years)	

PREPRINTS RECEIVED, JANUARY – MARCH, 1988

ANTONUCCI, R.R.J.; ULVESTAD, J.S. A Large New Family of Compact Radio Sources in the Starburst Nucleus of NGC 253.

BARTHEL, P.D.; MILEY, G.K.; SCHILIZZI, R.T.; LONSDALE, C.J. Observations of the Large Scale Radio Structure in High Redshift Quasars.

BARVAINIS, R.; CLEMENS, D.P.; LEACH, R. Polarimetry at 1.3mm Using MILLIPOL: Preliminary Results for Orion.

BAUM, S.A.; HECKMAN, T.; BRIDLE, A.; VAN BREUGEL, W.; MILEY, G. Extended Optical Line Emitting Gas in Radio Galaxies: Broad Band Optical, Narrow Band Optical, and Radio Imaging of a Representative Sample.

BOWERS, P.F.; JOHNSTON, K.J. Envelope Structure of the Mira Variable U Orionis.

BOWERS, P.F.; KNAPP, G.R. Detection of HI Emission in the Circumstellar Envelope of Omicron Ceti (Mira)

BREGMAN, J.N.; GLASSGOLD, A.E.; HUGGINS, P.J.; KINNEY, A.L.; ET AL Multifrequency Observation of the Optically Violent Variable Quasar 3C 446.

BRINKS, E.; KLEIN, U. Dark Matter in the Dwarf Galaxy II Zwicky 40.

BURNS, J.O.; MOODY, J.W.; GREGORY, S.A. Radio Sources Associated with Emission-Line Galaxies in the Bootes Void.

CONDON, J.J.; BRODERICK, J.J. Radio Identifications of UGC Galaxies: Starbursts and Monsters.

CORNWELL, T.J. A Novel Principle for Optimization of the Instantaneous Fourier Plane Coverage of Correlation Arrays.

DE RUITER, H.R.; PARMA, P.; FANTI, R.; EKERS, R.D. B2 1637+29, A Massive Radio Galaxy Probing a Poor but Gas Rich Group.

DICKEY, J.M.; BRINKS, E. An HI Absorption Survey of Messier 31.

GIOVANNINI, G.; FERETTI, L.; GREGORINI, L.; PARMA, P. Radio Nuclei in Elliptical Galaxies.

GREGORINI, L.; PADRIELLI, L.; PARMA, P.; GILMORE, G. Radio Galaxies of Intermediate Strength I. VLA Observations.

HERMSEN, W.; WILSON, T.L.; BIEGING, J.H. VLA Maps of Ammonia in Orion-KL: Fine Scale Structure and Geometry.

HEWITT, J.N.; TURNER, E.L.; SCHNEIDER, D.P.; BURKE, B.F.; ET AL The Sub-arcsecond Structure of MG1131+0456: an Einstein Ring Gravitational Lens?

HUTCHINGS, J.B.; PRICE, R.; GOWER, A.C. Radio Evolution of Quasars at Z<1.

ITOH, M.; INAGAKI, S.; SASLAW, W.C. Gravitational Clustering of Galaxies: Comparison between Thermodynamic Theory and N-Body Simulations.

JANNUZI, B.T.; BLACK, J.H.; LADA, C.J.; VAN DISHOECK, E.F. The Small Molecular Cloud toward HD 169454.

JOY, M.; GHIGO, F.D. Luminous Extranuclear Star Formation in the Interacting Galaxy Arp 118 (NGC 1143/44)

KELLERMANN, K.I.; FOMALONT, E.B. The Distribution of Faint Radio Sources at 6 cm.

KIM, D.-W.; GUHATHAKURTA, P.; VAN GORKOM, J.H.; JURA, M.; KNAPP, G.R. HI Observations of the Elliptical Galaxies NGC 2974 and NGC 5018.

KNAPP, G.R.; BOWERS, P.F. Small Scale Structure in the Interstellar Medium. I. Discovery of Very Small Molecular Clouds toward alpha Orionis.

LADA, E.A.; BLITZ, L. Two Populations of Diffuse Molecular Clouds.

LIKKEL, L.; MORRIS, M. The Circumstellar Water Fountains of IRAS 16342-3814: A Very-High-Velocity Bipolar Outflow.

LIZANO, S.; HEILES, C.; RODRIGUEZ, L.F.; KOO, B.-C.; ET AL Neutral Stellar Winds that Drive Bipolar Outflows in Low-Mass Protostars.

MANGUM, J.G.; ROOD, R.T.; WADIAK, E.J.; WILSON, T.L. Observations of the 13C Isomers of Cyanoacetylene: Implications for Carbon Isotope Studies in the Milky Way.

MASSI, M.; FELLI, M.; PALLAVICINI, R.; TOFANI, G.; ET AL VLBI Observations of RS CVn and Algol-Type Binaries.

MATHIEU, R.D.; BENSON, P.J.; FULLER, G.A.; MYERS, P.C.; SCHILD, R.E. L43: An Example of Interaction between Molecular Outflows and Dense Cores.

MEAD, K.N. Molecular Clouds in the Outer Galaxy: II. CO Maps of Individual Clouds.

MEAD, K.N.; KUTNER, M.L. Molecular Clouds in the Outer Galaxy: III. CO Studies of Individual Clouds.

MOLNAR, L.A.; REID, M.J.; GRINDLAY, J.E. VLBI Observations of Expansion in Cygnus X-3.

PAN, S.-K.; KERR, A.R.; FELDMAN, M.J.; KLEINSASSER, A.W.; ET AL An SIS Mixer for 85-116 GHz Using Inductively Shunted Edge-Junctions.

REID, M.J.; SCHNEPS, M.H.; MORAN, J.M.; GWINN, C.R.; ET AL The Distance to the Center of the Galaxy: H2O Maser Proper Motions in Sgr B2(N)

SANDERS, D.B.; SCOVILLE, N.Z.; SOIFER, B.T. IRAS 14348-1447, an Ultraluminous Pair of Colliding, Gas-Rich Galaxies: The Birth of a Quasar?

SAVAGE, A.; JAUNCEY, D.L.; WHITE, G.L.; PETERSON, B.A.; ET AL A Complete Sample of Flat-Spectrum Radio Sources from the Parkes 2.7 GHz Survey.

SCHWAB, F.R. VLBI Imaging Techniques.

SKILLMAN, E.D.; TERLEVICH, R.; TEUBEN, P.J.; VAN WOERDEN, H. H I Synthesis Observations of the Dwarf Irregular Galaxy Sextans A.

STINEBRING, D.R.; CONDON, J.J. Pulsar Flux Stability and Refractive Interstellar Scintillation.

STONE, J.L. JR; WILSON, A.S.; WARD, M.J. Collimated Nuclear Ejection of Radio-Emitting Plasma in the Seyfert Galaxy NGC 4388.

SURDEJ, J.; SWINGS, J.-P.; MAGAIN, P.; BORGEEST, U.; ET AL Search for Gravitational Lensing from a Survey of Highly Luminous Quasars.

TAYLOR, A.R. Radio Imaging of Symbiotic Stars.

TAYLOR, A.R.; HJELLMING, R.M.; SEAQUIST, E.R.; GEHRZ, R.D. Radio Images of the Expanding Ejecta of Nova QU Vulpeculae 1984.

WALMSLEY, C.M.; BATRLA, W.; MATTHEWS, H.E.; MENTEN, K.M. Anti-inversion of the 12.1 GHz Methanol Line Towards Dark Clouds.

YUSEF-ZADEH, F.; MORRIS, M. The Northern Extension of the Radio Arc near the Galactic Center.