NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

01 January - 31 March 1991

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A. TELESCOPE USAGE

The NRAO telescopes have been scheduled for research and maintenance in the following manner during the first quarter of 1991.

	140-ft	12-m	VLA
Scheduled observing (hrs)	1732.50	1663.50	1630.50
Scheduled Maintenance and Equipment Changes	139.75	64.25	252.20
Scheduled Tests and Calibrations	271.75	415.25	267.20
Time Lost	179.25	372.75	88.04
Actual Observing	1553.25	1290.75	1542.46

B. 140-FT TELESCOPE

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
G314	Goldstein, S. (Virginia) Hennessy, G. (Virginia)	Observations at 230 and 235 MHz in an attempt to detect diffuse synchrotron emission from open star clusters.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B538	Bell, M. (Herzberg) Feldman, P. (Herzberg) MacLeod, J. (Herzberg) Watson, J. (Herzberg) Seaquist, E. (Toronto)	Study at 17.6 GHz hydrogen recombination lines with high delta n values.
B539	Bell, M. (Herzberg) Feldman, P. (Herzberg) Watson, J. (Herzberg)	Observations over the range 22.2 GHz to 24 GHz to identify some of the lines detected previously in TMC1.
B540	Bell, M. (Herzberg) Feldman, P. (Herzberg) Watson, J. (Herzberg)	Observations at 1 and 1.3 cm of vibrational lines and isotopomers of HC_5N in IRC+10216.
B541	Bell, M. (Herzberg) Avery, L (Herzberg) Feldman, P. (Herzberg) Watson, J. (Herzberg)	Spectral survey of W51 between 17.5 and 25 GHz.

No.	Observer(s)	Program
D166	Dutrey, A. (Grenoble) Castets, A. (Grenoble) Duvert, G. (Grenoble) Bally, J. (Bell Labs) Langer, W. (Princeton)	Observations at 1.3 cm of NH_3 in Ori A to use in a multitransition study of CO.
D168	Duncan, R. (Texas) Higdon, J. (Texas) Fisher, J. R.	Search at 570 MHz for the dark lens responsible for quasar pair Q2345+007 in redshifted HI.
H274	He, L. (Purple Mountain)	Search at 22 GHz for H_2O masers in the direction of IRAS point sources.
I15	Irvine, W. (Massachusetts) Ungerechts, H. (Massachusetts) Brown, R. (Monash Univ.) Godfrey, P. (Monash Univ.) Ohishi, M. (Nobeyama)	Studies at 0.9 and 1.2 cm of the related chemistry of H_2C_3O, C_3O, and HC_2CHO.
M303	Matthews, H. (Hawaii) Avery, L. (Herzberg) Bell, M. (Herzberg) Madden, S. (Massachusetts) Irvine, W. (Massachusetts)	Search at 27 GHz for cyclopropenylidene.
M310	Matthews, H. (Hawaii) Friberg, P. (Hawaii) Watt, G. (Hawaii) Irvine, W. (Massachusetts)	Survey at 30 GHz for interstellar SO.
T287	Thaddeus, P. (CFA) Vrtilek J. (CFA)	Search at 17 and 20 GHz for H_2C_3 and H_2C_4.
V72	Vanden Bout, P. Brown, R.	Search in the range of 21-23 GHz for CO emission in High-Z QSO's.
W280	Wootten, H. A.	H_2O monitoring in star-forming cores in ρ Oph.
W282	Wilson, T. (MPIR, Bonn) Bania, T. (Boston) Huttemeister, S. (Bonn) Martin-Pintado, J. (IRAM)	NH_3 observations at 1.25 cm to determine molecular temperatures of Galactic Center clouds.
W295	Wootten, H. A.	Study at 1.25 cm of deuterated NH_3 in interstellar clouds.
X3	Xiang, D. (Purple Mountain) Turner, B.	Search at 22.275 GHz for H_2O masers in established molecular outflow sources.

No.	Observer(s)	Program
X4	Xiang, D. (Purple Mountain) Turner, B.	Study at 22.235 GHz of time variations of H_2O masers associated with regions of star formation.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
B484	Backer, D. (Berkeley) Foster, R. (NRL)	Timing observations over the range of 800-840 MHz and at 1330 MHz of PSR 1821-24 and other millisecond pulsars.
F104	Fruchter, A. (DTM) Nice, D. (Princeton) Stinebring, D. (Oberlin) Taylor, J. (Princeton) Thorsett, S. (Princeton)	Observations of the Terzan Pulsar at 330, 600, and 800 MHz.
F105	Foster, R. (NRL) Fiedler, R. (NRL) Cordes, J. (Cornell)	Observations at 800-840 and 1330 MHz to obtain the dynamic spectra of strong radio pulsars.
K331	Kulkarni, S. (Caltech) Frail, D. Thorsett, S. (Princeton)	Observations at 570 MHz of PSR1758-24.
T265	Taylor, J. (Princeton) Stinebring, D. (Oberlin) Nice, D. (Princeton) Thorsett, S. (Princeton) Arzoumanian, Z. (Princeton)	Pulsar timing observations over the range of 800-840 and at 1330 MHz.

The following very long baseline programs were conducted and the stations used are coded as follows.

B - Effelsburge, MPIR 100 m
Dm - Goldstone DSN 210 ft
Ds - Madrid DSN 210 ft
G - Green Bank 140 ft
Jb - Jodrell Bank 250 ft
Km - Haystack 120 ft
Lm - Medicina 32 m
Ma - Nobeyama 45 m
Mb - Itapetinga, Brazil 14 m
N - NRL, Maryland Point 85 ft
No - Noto, Sicily 32 m
O - Owens Valley 130 ft
Pt - Pietown 25 m
R - Crimea, USSR 30 m
Sn - Onsala 20 m
T - Torun 15 m
VLBA - All available VLBA 25 m
Wn - Westerbork n=1-14x26 m
Wt - Wettzell 20 m
Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
GB3	Bartel, N. (CFA) Rupen, M. (CFA) Shapiro, I. (CFA) Preston, R. (JPL) Rius, A. (Madrid) Hirabayashi, H. (Nobeyama) Kobayashi, H. (Nobeyama)	Observations at 3.6 cm in an attempt to make a movie of an exploding star, with telescopes B, Lm, No, T, Km, G, O, Y_{27}, Dm, and Ds.
GC3	Carrara, E. (Itapetinga Obs.) Abraham, Z. (Itapetinga Obs.) Zensus, A. Cohen, M. (Caltech) Unwin, S. (Caltech)	Studies at 2.8 cm of the time evolution of the spatial structure in 3C 273 and 3C 279, with telescopes B, Lm, Km, G, O, Pt, and Mb.
GG5	Giovannini, G. (Bologna) Comoretto, G. (Arcetri) Feretti, L. (Bologna) Venturi, T. (Bologna) Wehrle, A. (Caltech)	Observations at 3.6 cm of the low luminosity radio galaxy 3C 338, with telescopes B, Sn, Lm, N, Wn, Jb, Km, G, Y_{27}, and VLBA.
GH1	Hough, D. (Trinity) Vermeulen, R. (Caltech) Zensus, A. Readhead, A. (Caltech) Porcas, R. (MPIR, Bonn)	Measurements at 2.8 and 3.6 cm of superluminal speeds in the cores of double-lobed quasars 3C 245 and 3C 263, with telescopes B, Lm, Km, G, O, and Pt.
GS2	Schauer, P. (Cambridge) Black, A. (Cambridge) Spencer, R. (Manchester)	Observations at 90 cm of 3C 295, with telescopes Jb, Wn, T, G, O, Y_1, and VLBA.
GS3	Sakurai, T. (Iowa) Spangler, S. (Iowa)	Studies at 90 cm of density turbulance in outer corona and solar wind, with telescopes Jb, Wn, T, R, G, O, Y_{27}, and VLBA.
GV2	de Vicente, P. (CAY, Yebes) Alef, W. (MPIR, Bonn) Romney, J. Kellermann, K.	Observations at 3.6 cm of the nucleus structure of 3C 84, with telescopes B, Lm, Sn, N, Wt, Km, G, O, Y_1, and VLBA.
GV5	Vermeulen, R. (Caltech) Hough, D. (Trinity) Readhead, A. (Caltech)	Observations at 2.8 and 3.6 cm of the double lobed quasar cores of 3C 347 and 3C 207, with telescopes B, Lm, Km, G, O, and Pt.

No.	Observer(s)	Program
GX1	Xu, W. (Caltech) Readhead, A. (Caltech) Pearson, T. (Caltech) Wilkinson, P. (Manchester) Polatidis, A. (Manchester)	Observations at 3.6 cm of 1347+539 and 1418+546, with telescopes B, Lm, Sn, No, Km, G, O, Y_1, and VLBA.
GZ1	Zhang, F. J. (Jodrell Bank) Marscher, A. (Boston)	Studies at 3.6 cm of the peaked variable spectrum source 0528+134, with telescopes B, Sn, Lm, N, Jb, Km, G, O, Y_1, and VLBA.
UAH2	Unwin, S. (Caltech) Abraham, Z. (Itapetinga Obs.) Carrara, E. (Itapetinga Obs.) Zensus, A. Urry, C. (STScI) Wehrle, A. (Caltech)	Studies at 3.6 cm of the dynamics of the jet in 3C 279, with telescopes B, Sn, Lm, N, Km, G, O, Y_1, and VLBA.
UAH4	Akujor, C. (Manchester) Porcas, R. (MPIR, Bonn)	Observations at 3.6 cm of 0646+60, with telescopes Sn, B, Jb, Lm, No, T, VLA, GB, O, Km, and VLBA.
UH1	Hough, D. (Trinity) Zensus, A. Vermeulen, R. (Caltech) Readhead, A. (Caltech) Porcas, R. (MPIR, Bonn) Rius, A. (NASA/INTA)	Search at 3.6 cm for superluminal motion in very weak nuclei of selected double-lobed quasars, with telescopes B, Km, G, Y_{27}, and Dm.
UZ1	Zensus, A. Porcas, R. (MPIR, Bonn)	Studies at 2.8 cm of the kinematics in an orientation-unbiased sample of compact radio sources, with telescopes B, Km, G, O, and Pt.

C. 12-M TELESCOPE

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A102	Adler, D. (Illinois) Allen, R. (Illinois) Lo, K. (Illinois) Sukumar, S. (Illinois)	Continuing studies of the interstellar medium in the spiral galaxy M83.

No.	Observer(s)	Program
A103	André, P. Leous, J. (Penn State) Greene, T. (Arizona) Young, E. (Arizona)	Comprehensive study of the star-forming core L1495 in Taurus.
A104	André, P. Loren, R. (unaffiliated) Wootten, H. A. Despois, D. (Bordeaux)	CS mapping of the dense gas of the ρ Oph cloud.
B537	Blitz, L. (Maryland) Williams, J. (Berkeley)	Study of the structure of a young GMC.
B545	Bieging, J. (Arizona)	Study of the chemical structure of the IRC+10216 envelope.
G311	Gordon, M. Martin-Pintado, J. (CAY, Yebes)	Monitoring program for the RRL maser in MWC 349.
G319	Gordon, M.	The detection and mapping of CO in elliptical galaxies.
G320	Gordon, M.	An independent investigation of plasma temperatures in HII regions.
H267	Ho, P. (CFA) Szczepanski, J. (MIT) Ho, L. (CFA) Wiseman, J. (CFA) Gomez, J. (CFA)	Study of molecular cloud interactions in the galactic center.
H272	Hollis, J. M. (NASA/GSFC) Snyder, L. (Illinois) Ziurys, L. (Arizona State)	The search for the confirming transition of HNO.
L255	Liszt, H.	Search for extragalactic O_2.
L256	Lada, C. (CFA) André, P.	Outflow survey around low-luminosity YSO's in Taurus.
L257	Lada, E. (CFA)	Study of the effects of density and core structure on star formation efficiency.
L259	Lo, K. (Illinois)	CO observations of dwarf irregular galaxies.

No.	Observer(s)	Program
M311	McCullough, P. (Berkeley) Reach, W. (Berkeley) Heiles, C. (Berkeley)	Study of globules in HII regions.
P152	Petuchowski, S. (NASA/GSFC) Bennett, C. (NASA/GSFC)	Study of SO in starburst galaxies.
P156	Pound, M. (Maryland) Blitz, L. (Maryland)	A search for proto-brown dwarfs.
R249	Rho, J. (Maryland) Blitz, L. (Maryland)	Observations of CO in Seyfert-matched normal galaxies.
S326	Szczepanski, J. (MIT) Ho, P. (CFA)	Study of the gas feeding of the galactic center region.
T281	Turner, B.	A search for vinyl (CH_2CH).
T288	Turner, B.	Study of ortho/para species to determine gas/grain interactions.
T289	Turner, B.	A search for PO in cold dense molecular clouds.
T291	Turner, J. (UCLA) Hurt, R. (UCLA) Ho, P. (CFA) Martin, R. (Arizona)	Study of CO 2-1 in Maffei 2.
V77	Verter, F. (NASA/GSFC) Hodge, P. (Washington)	Study of molecular gas emissivity in GR8.
W277	Wootten, H. A. Sahai, R. (Chalmers/Onsala)	Interrupted mass loss in AGB Red Giants: CO observations.
W283	Wilner, D. (Berkeley) Welch, W. (Berkeley) Bieging, J. (Arizona)	A multi-transition study of OMC-N.
W284	Wilson, C. (Caltech)	Study of the molecular interstellar medium in NGC 6822.
W287	Wall, W. (Texas) Jaffe, D. (Texas)	Study of the opacity of ^{13}CO emission in M82 and M51.
Y9	Yun, M. (CFA) Ho, P. (CFA)	Study of the interaction between ICM and molecular clouds in Virgo spirals.

No.	Observer(s)	Program
Z88	Ziurys, L. (Arizona State)	Confirmation of interstellar MgS.
Z89	Ziurys, L. (Arizona State) Cahill, P. (Arizona State) Barclay, W. (Arizona State)	A proposal to complete a 270-300 GHz spectral-line survey of Orion.

D. THE VERY LARGE ARRAY

First quarter configurations were: C configuration, January 1-29; C/D configuration, January 29-February 26; and D configuration, February 26-March 31.

No.	Observer(s)	Program
AA114	Aller, H. (Michigan) Aller, M. (Michigan) Bregman, J. (Michigan)	X-ray/radio variability in active galactic nuclei (with ROSAT). 2 cm.
AA116	Alexander, P. (Cambridge) Crane, P. Wilding, T. (Cambridge) Pooley, G. (Cambridge)	Star formation in nine late-type galaxies. 3.8 cm.
AA118	Anderson, M. (Minnesota) Katz, D. (Minnesota) Rudnick, L. (Minnesota)	Spectral index variations in Shell Supernova Remnants. 6 cm.
AA119	Andre, P. Wootten, H. A. Despois, D. (Bordeaux) Sargent, A. (Caltech)	Circumstellar gas around the very young outflow-driving source VLA 1623. 1.3 cm line.
AA122	Allen, J. (Iowa) Molnar, L. (Iowa)	Radio emission from x-ray binary systems: Monitoring Cygnus X-1. 1.3, 2, 3.8, 6, and 20 cm.
AB414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2 and 6 cm.
AB456	Burke, B. (MIT) Hewitt, J. (Haystack) Roberts, D. (Brandeis)	Monitoring Lens 0957+561. 6 cm.
AB555	Blommaert, J. (Leiden) van Langevelde, H. (Leiden) Habing, H. (Leiden)	Low luminosity OH/IR stars in the galactic disk. 18 cm line.

No.	Observer(s)	Program
AB573	Becker, R. (Calif., Davis) Helfand, D. (Columbia) White, R. (STScI)	A sample of O-stars from a survey of galactic plane. 6 cm.
AB578	Bowers, P. (SFA/NRL) Knapp, G. (Princeton)	Search for ionized gas in globular clusters. 3.8 cm.
AB585	Bietenholz, M. (Toronto) Frail, D.	Compact synchrotron nebula around the Vela pulsar. 6 cm.
AB586	Brinks, E. Skillman, E. (Minnesota) Taylor, C. (Minnesota)	Search for intergalactic HI clouds. 20 cm line.
AB587	Burns, J. (NMSU) Clarke, D. (Illinois)	The inner lobes and jet of Centaurus A. 3.8 cm.
AB588	Buta, R. (Alabama) Higdon, J. (Texas)	NGC 5850: a ringed barred spiral with interacting nearby elliptical. 20 cm line.
AB591	Beck, R. (MPIR, Bonn) Horellou, C. (Meudon) Neininger, N. (MPIR, Bonn) Brouillet, N. (MPIR, Bonn)	The detailed magnetic field structure of M51. 6 cm.
AB595	Beck, R. (MPIR, Bonn) Ehle, M. (MPIR, Bonn) Neininger, N. (MPIR, Bonn)	Magnetic fields and star formation in NGC 6946. 6 cm.
AB597	Bookbinder, J. (CFA) Pye, J. (Leicester) Bromage, G. (SERL, R.A. Lab) Saar, S. (CFA)	Stellar flares on dMe stars: multiband observations. 2, 3.8, 6, and 20 cm line.
AB599	Brett, B. (Manchester) Beck, R. (MPIR, Bonn)	The magnetic field of NGC 2903. 6 cm.
AB601	Brown, D. (Northwestern) Wood, D. Yusef-Zadeh, F. (Northwestern)	Survey of a sample of molecular outflow sources. 3.8 cm.
AC278	Carilli, C. Ho, P. (Harvard)	Two nuclear starburst galaxies. 3.8, 6, and 20 cm.
AC285	Carilli, C. van Gorkom, J. (Columbia) Womble, D. (Calif., San Diego)	HI of quasar-galaxy pair PHL 1226-IC 1746. 20 cm line.

No.	Observer(s)	Program
AC286	Churchwell, E. (Wisconsin) Kurtz, S. (Wisconsin) Wood, D.	The dynamics and structure of ultracompact HII regions. 1.3 cm line.
AC290	Curiel, S. (CFA) Rodriguez, L. (Mexico/UNAM) Ho, P. (CFA)	Radio continuum sources in the HH7-11 region. 3.8 and 20 cm.
AC291	Caillault, J. (Georgia) Magnani, L. (Arecibo)	A search for PMS stars in the high-latitude molecular clouds. 3.8 cm.
AC292	Carpenter, J. (Massachusetts) Snell, R. (Massachusetts) Schloerb, F. (Massachusetts)	Search for embedded massive stars in the Gem OB1 molecular cloud complex. 3.8 and 20 cm.
AC294	Corbelli, E. (Arcetri) Schneider, S. (Massachusetts)	Neutral hydrogen absorption in 3C 275.1/NGC 4651. 20 cm line.
AD253	de Pater, I. (Calif., Berkeley)	Jupiter's changing atmospheric morphology. 1.3, 2, 3.8, and 6 cm.
AD258	Dahlem, M. (MPIR, Bonn) Koribalski, B. (Bonn U.) Mebold, U. (Bonn U.)	Mass outflow from the disk of interacting galaxy NGC 1792. 20 cm line.
AD259	Dettmar, R. (Bonn U.) Koribalski, B. (MPIR, Bonn) Wielebinski, R. (MPIR, Bonn)	A sensitive high frequency study of M104. 6 cm.
AD260	Dubner, G. (Buenos Aires) Arnal, M. (IAR, Buenos Aires) Winkler, F. (Middlebury College) Goss, W. M.	Galactic plane supernovae remnants. 20 cm.
AD261	Dulk, G. (Colorado) Bastian, T. Belkora, L. (Colorado) Lindsey, C. (Hawaii) Roellig, T. (NASA/Ames)	Simultaneous sunspots and plage from the JCMT and VLA. 1.3 and 2 cm.
AE064	Elias, N. (Pennsylvania)	Serpentid binary star V367 Cygni. 6 and 3.8 cm.
AE068	Elias, N. (Pennsylvania)	Detection of more serpentids. 3.6 and 6 cm.
AE073	Eales, S. (Toronto) Rawlings, S. (Cambridge) Alexander, P. (Cambridge)	Search for HI around protogalaxy candidates 0902+34 and 1232+39. 90 cm line.

No.	Observer(s)	Program
AE076	Edelson, R. (Colorado) Malkan, M. (UCLA) Rush, B. (UCLA) Spinoglio, L. (IAS, Frascati)	The 12 μm Seyfert Galaxy sample. 6 and 20 cm.
AF195	Feigelson, E. (Penn State) Hertz, P. (NRL) Brinkmann, W. (MPIfEP, Garching) Wielebinski, R. (MPIR, Bonn)	Survey of north ecliptic pole region in support of ROSAT mission. 20 cm.
AF198	Frail, D. Kulkarni, S. (Caltech)	A possible PSR/SNR association. 20 cm.
AF207	Fruchter, A. (DTM/Carnegie) Goss, W. M.	Deep 6 cm images of Terzan 5 and NGC 6440. 6 cm.
AF208	Fomalont, E.	A peculiar Im galaxy. 20 cm line.
AG315	Garwood, R. (Pittsburgh) Briggs, F. (Pittsburgh) Wolfe, A. (Calif., San Diego)	HI absorption at z=3.0626 in PKS 0336-017. 90 cm line.
AG316	Gorham, P. (Caltech) Kulkarni, S. (Caltech) Prince, T. (Caltech)	Small-diameter sources from Clark Lake galactic plane survey. 20 cm.
AG317	Gregorini, L. (Bologna) de Ruiter, H. (Bologna) Parma, P. (Bologna) Vettolani, G. (Bologna) Ekers, R. (AT, Australia) Sadler, E. (AAO)	A complete sample of optically selected dumb-bells. 6 cm.
AG318	Gunn, J. (Princeton) Knapp, G. (Princeton) Athanassoula, E. (Marseille Obs) Bosma, A. (Marseille Obs) van Gorkom, J. (Columbia)	Spiral structure and the disk/halo mass ratio. 20 cm line.
AG320	Geldzahler, B. (ARC) Nash, A. (ARC)	Open clusters and OB associations: search for parallax objects. 20 cm.

No.	Observer(s)	Program
AG323	Goss, W. M. Cowan, J. (Oklahoma) Ekers, R. (AT, Australia) Sramek, R. Roberts, D. (Oklahoma) Branch, D. (Oklahoma)	H66α recombination lines observations of the PN or G25.57+0.2. 1.3 cm.
AH295	Habing, H. (Leiden) Goss, W. M. Winnberg, A. (Chalmers, Onsala) van Langevelde, H. (Leiden)	Monitoring OH/IR stars at the galactic center. 20 cm line.
AH364	Hunt, G. Patnaik, A. (Manchester) Salter, C. (TIFR) Shaver, P. (ESO)	High surface brightness SNRs and SNRs with "blow-outs." 90 cm.
AH390	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Monitoring radio novae. 20, 6, 3.6, and 2 cm.
AH415	Hankins, T. (NMIMT) Kobulnicky, H. (Iowa) McKinnon, M. (NMIMT) Rankin, J. (Vermont)	P-band polarimetry of PSR1702-19. 90 cm.
AH417	Hibbard, J. (Columbia) van Gorkom, J. (Columbia)	Interacting and merging galaxies. 20 cm line.
AH422	Ho, P. (Harvard) Ho, L. (CFA) Szczepanski, J. (CFA) Jackson, J. (MPIR, Bonn)	Molecular clouds within 10 pc of the galactic center. 1.3 cm line.
AH425	Hankins, T. (NMIMT)	Ultra-high time resolution measurements of Crab Pulsar PSR0531+21. 3.8, 6, and 20 cm.
AH426	Harris, D. (CFA) Willis, A. (DRAO) Dewdney, P. (DRAO) McHardy, I. (Southampton) Stern, C. (CFA)	Radio halo in a distant galaxy cluster. 6 cm.
AH430	Hummel, E. (Manchester) Beck, R. (MPIR, Bonn) Krause, M. (MPIR, Bonn)	The B-field structure in the central 1 kpc of IC 342. 3.8 cm.

No.	Observer(s)	Program
AH444	Hjellming, R. Han, X. (NMIMT) Roussel-Dupre, D. (LANL)	Search for radio counterpart of GRS1217+006.
AI042	Impey, C. (Arizona) Foltz, C. (MMTO) Weymann, R. (DTM/Carnegie) Hewett, P. (Cambridge)	The radio properties of optically selected quasars. 3.8 cm.
AJ191	Jauncey, D. (CSIRO) Jones, D. (JPL) Meier, D. (JPL) Murphy, D. (JPL) Preston, R. (JPL)	Monitoring possible Einstein ring 1830-211. 3.6 cm.
AJ195	Jackson, J. (MPIR, Bonn) Rieu, N. (Meudon) Ho, P. (Harvard)	HC_3N in the starburst galaxies M82 and IC 342. 3.8 cm line.
AJ199	Joersaeter, S. (ESO) van Moorsel, G. (ESO)	HI mapping of barred spiral NGC1365. 20 cm line.
AK243	Krause, M. (MPIR, Bonn) Lesch, H. (Heidelburg Obs)	Structure in edge-on galaxies: NGC 2638 and NGC 5907. 6 and 20 cm.
AK247	Knapp, G. (Princeton) Bowers, P. (NRL) Young, K. (Caltech) Phillips, T. (Arecibo)	Circumstellar envelopes of evolved stars. 3.8 cm.
AK251	Koribalski, B. (Bonn U.) Dahlem, M. (MPIR, Bonn) Mebold, U. (Bonn U.) Klein, U. (MPIR, Bonn)	Peculiar filaments in the halo of NGC 1448. 20 cm line.
AK262	Krishna, G. (TIFR) Kulkarni, V. (TIFR)	Flux variability of nuclear cores in giant radio galaxies. 6 cm.
AK264	Kundu, M. (Maryland) White, S. (Maryland) Gopalswamy, N. (Maryland) Schmahl, E. (Maryland) Golla, T. (Maryland)	Simultaneous VLA and balloon-born X-ray solar flare studies. 2 and 6 cm.
AK267	Koo, B. (CFA) Yun, M. (CFA) Ho, P. (CFA)	Structure of an expanding HI shell in the supernova remnant CTB 80. 20 cm line.

No.	Observer(s)	Program
AK268	Koo, B. (CFA) Yun, M. (CFA) Ho, P. (CFA) Kumar, P. (NCAR) Riffert, H. (Tubingen) Heiles, C. (Calif., Berkeley)	HI study of two giant molecular clouds near the galactic center. 20 cm line.
AK279	Kulkarni, S. (Caltech) Frail, D.	The pulsar in G5.4-1.1. 20 cm.
AL150	Lestrade, J.-F. (JPL) Preston, R. (JPL)	Statistical properties of RS CVn stars.
AL216	Leahy, D. (Calgary)	Sharpless regions S217 and S219. 6 and 20 cm.
AL229	La Franca, F. (IRA, Bologna) Cristiani, S. (Padua) Gregorini, L. (Bologna) de Ruiter, H. (Bologna) Owen, F.	A complete sample of optically selected quasars. 6 cm.
AL230	Lang, K. (Tufts) Willson, R. (Tufts)	Solar activity during the max 91 campaign. 2, 3.8, 20, and 90 cm.
AL232	Langston, G. (NRL)	K-band bright compact sources. 1.3 cm.
AL234	Leone, F. (Catania Obs.) Umana, G. (Bologna)	Synoptic observation of CP2, chemically peculiar stars. 6 cm.
AL235	Lizano, S. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Canto, J. (Mexico/UNAM) Escalante, V. (Mexico/UNAM)	Atomic hydrogen in reflection nebulae. 20 cm line.
AL236	Lacy, M. (Cambridge) Warner, P. (Cambridge)	Observations of NGC 6512. 20 and 90 cm.
AM279	Melnick, G. (CFA) Rodriguez, L. (Mexico/UNAM)	Atomic hydrogen in the M17 photodissociation region. 20 cm line.
AM310	Malkan, M. (UCLA) Baganoff, F. (UCLA)	Variability of northern ecliptic pole active galactic nuclei. 2, 3.8, and 6 cm.
AM312	McCullough, P. (Calif., Berkeley) Heiles, C. (Calif., Berkeley)	A rocketing globule in the HII region NGC 281. 20 cm line.

No.	Observer(s)	Program
AM314	McKinnon, M. (NMIMT)	Pulsar mode-switching and depolarization. 20 cm.
AM315	McMahon, P. (Columbia) Richter, O. (STScI) van Gorkom, J. (Columbia) Ferguson, H. (Johns Hopkins)	A complete volume limited survey of the hydra cluster of galaxies. 20 cm line.
AM316	Migenes, V. (Manchester) Cohen, R. (Manchester) Wilson, T. (MPIR, Bonn) Johnston, K. (NRL)	(3,2) transition of NH_3 in star forming regions. 1.3 cm.
AM317	Moore, E. (Florida) Gottesman, S. (Florida)	HI observations of barred spirals NGC 1398 and NGC 1784. 20 cm line.
AM320	Mehringer, D. (Chicago) Yusef-Zadeh, F. (Northwestern) Palmer, P. (Chicago) Goss, W. M.	H_2CO toward the Sgr B complex near the galactic center. 6 cm line.
AM321	Moriarty-Schieven, G (JPL) Wannier, P. (JPL)	Search for circumstellar disks around T Tauri-like stars. 1.3 cm line.
AM324	Marvel, K. (NMSU)	Masers near the galactic center. 18 and 1.3 cm line.
AN055	Nash, A. (ARC) Geldzahler, B. (ARC)	Survey of radio emission from Cepheid variables. 3.8 cm.
AO104	Owen, F. White, R. (STScI)	Completion of two radio surveys of Abell clusters. 20 cm.
AP192	Pottasch, S. (Groningen/Kapteyn) Bignell, R. C.	Stellar evolution AGB through planetary nebulae. 2, 3.8, and 6 cm.
AP196	Puche, D. Brinks, E. Westpfahl, D. (NMIMT)	Structure of the ISM in nearby dwarf galaxies. 20 cm line.
AP197	Partridge, R. B. (Haverford) Franceschini, A. (Padua)	Survey of galaxies in the CFA deep redshift survey. 20 cm.
AP198	Patterson, R. (Virginia) Thuan, T. (Virginia) Schneider, S. (Massachusetts)	HI distribution and kinematics of extreme dwarf galaxies. 20 cm line.

No.	Observer(s)	Program
AP202	Puche, D.	Study of dwarf galaxies in the Virgo low velocity cloud. 20 cm line.
AR226	Rucinski, S. (York U.)	Three T Tauri stars. 3.5, 6, and 20 cm.
AR228	Roberts, D. van Gorkom, J. (Columbia) Goss, W. M. Leahy, P. (Manchester)	Recombination Line observations of Sgr A West. 3.8 cm line.
AR231	Reid, M. (CFA) Menten, K. (CFA)	"Light curves" for Mira variables. 3.8 cm.
AR235	Rhee, G. (NMSU)	High redshift galaxies: morphology of sources. 2 cm.
AR239	Rawlings, S. (Cambridge) Eales, S. (Toronto)	High redshift galaxy candidates. 3.5 cm.
AS419	Schneider, S. (Massachusetts) Schombert, J. (Michigan) Bothun, G. (Michigan) Knezek, P. (Massachusetts)	The neutral hydrogen properties of LSB giants. 20 cm line.
AS421	Simkin, S. (Michigan State) Sadler, E. (AAO)	HI content of powerful radio galaxies. 20 cm line.
AS423	Skinner, S. (Colorado) Brown, A. (Colorado) Linsky, J. (Colorado)	Spectral indices and variability of radio-emitting Herbig Ae/Be stars. 2, 3.8, 6, and 20 cm.
AS428	Sage, L. (MPIR, Bonn) Westpfahl, D. (NMIMT) Huchtmeier, W. (MPIR, Bonn)	A coordinated study of the ISM in nearby galaxies. 20 cm line.
AS430	Seaquist, E. (Toronto) Taylor, A. (Calgary) Krogulec, M. (Toronto) Weston, D. (York U.)	A survey of symbiotic stars. 3.8 cm.
AT108	Terlevich, R. (RGO) Brinks, E. Skillman, E. (Minnesota) Terlevich, E. (RGO)	Seyfert galaxy NGC 1068. 20 cm line.

No.	Observer(s)	Program
AT109	Torrelles, J. (IAP, Granada) Gomez, J. (IAP, Granada) Verdes-Montenegro,L. (IAP, Granada) Rodriguez, L. (Mexico/UNAM) Gomez, Y. (Mexico/UNAM) Roth, M. (Mt. Wilson) Tapia, M. (Mexico/UNAM)	Southern blister HII region GM24. 3.8 and 6 cm line.
AT111	Thorsett, S. (Princeton) Nice, D. (Princeton) Stinebring, D. (Oberlin) Taylor, J. (Princeton)	The eclipsing binary millisecond pulsar in Terzan 5. 20 cm.
AT112	Thorsett, S. (Princeton) Stinebring, D. (Oberlin) Taylor, J. (Princeton) Hankins, T.	Timing fast pulsars at the VLA. 20 and 90 cm.
AT113	Troland, T. (Kentucky) Crutcher, D. (Illinois) Roberts, D. Goss, W. M.	New VLA Zeeman observations of Orion A, Orion B, and W3. 20 cm line.
AT114	Taylor, A. (Calgary) Dougherty, S. (Calgary)	Monitoring of radio variable Be stars. 3.8 cm.
AT118	Thorsett, S. (Princeton) Taylor, J. (Princeton) McKinnon, M. (NMIMT)	Binary pulsar timing measurements: pulsars not accessible to Arecibo. 20 and 90 cm.
AT119	Thorsett, S. (Princeton) Taylor, J. (Princeton) Stinebring, D. (Oberlin) Hankins, T. (NMIMT)	Timing fast pulsars. 6 and 20 cm.
AT122	Torrelles, J.M. (IAA, Spain) Gomez, J.F. (CFA) Anglada, G. (Barcelona) Estalella (Barcelona)	Estimation of the H_2O maser positions. 1.3 cm line.
AU040	Uchida, K. (UCLA) Morris, M. (UCLA) Yusef-Zadeh, F. (Northwestern)	Study of a large supernova remnant near the galactic center. 3.8, 6, and 20 cm line.
AU041	Uson, J. Bagri, D. Cornwell, T.	Search for redshifted "21 cm" emission from Zel'dovich pancakes. 90 cm line.

No.	Observer(s)	Program
AV172	van Breugel, W. (Calif., Berkeley) Silk, J. (Calif., Berkeley) Fomalont, E. van Gorkom, J. (Columbia)	HI in the foreground of Fornax A. 20 cm line.
AV181	van Gorkom, J. (Columbia) van der Hulst, J. (Groningen)	HI imaging of nearby galaxy Centarus A. 20 cm line.
AV182	van Gorkom, J. (Columbia) Bothun, G. (Michigan) Impey, C. (Arizona)	HI imaging of low surface brightness galaxies. 20 cm line.
AV186	van Driel, W. (Amsterdam) van den Broek, A. (Amsterdam) de Jong, T. (Amsterdam)	The thermal radiation of extreme IRAS galaxies. 2 cm.
AW230	Wrobel, J. Unger, S. (RGO)	Monitoring of the Seyfert NGC 5548. 3.5 cm.
AW249	Wills, B. (Texas) Shastri, P. (Texas)	Core variability in lobe-dominated quasars. 6 cm.
AW261	Whiteoak, J. (Sydney) Gray, A. (Sydney) Cram, L. (Sydney) Goss, W. M.	High resolution imaging of a cluster near the galactic center. 20 cm.
AW266	Warwick, R. (Leicester) McHardy, I. (Southampton) Lehto, H. (Southampton)	Medium sensitivity survey at 20 cm in support of ROSAT observations. 20 cm.
AW267	Wootten, H. A. Mangum, J. (Texas) Butner, H. (NASA/Ames)	Structure of a cloud at the threshold of star formation. 2 cm line.
AW268	White, R. (STScI) Becker, R. (Calif., Davis) Wachter, S. (Calif., Davis) van Breugel, W. (Caltech)	Population studies of extragalactic flat-spectrum radio sources. 20 cm.
AW279	Wiseman, J. (CFA) Ho, P. (CFA)	Extended structure and high velocity outflows in OMC-1. 1.3 cm line.
AW280	Womble, D. (Calif., San Diego) Dickey, J. (Minnesota) Burbidge, E. (Calif., San Diego)	Probing the extent of galaxies: Ca II absorption vs HI emission. 20 cm line.

No.	Observer(s)	Program
AW281	Wootten, H. A. Rieu, N. (Meudon)	Circumstellar photochemistry of cyanopolyynes: HC_3N. 3.8 cm line.
AY037	Yusef-Zadeh, F. (Northwestern) Cornwell, T.	HH-like streamers in Orion. 3.8 and 6 cm.
AZ044	Zhao, J. Ekers, R. (AT, Australia) Goss, W. M. Lo, K. (Illinois) Narayan, R. (Steward)	Flux density variations caused by RISS in Sgr A. 3.8, 6, and 20 cm.
AZ046	Zwarthoed, G. (Amsterdam) Penninx, W. (Amsterdam)	Four unclassified low mass X-ray binaries. 6 cm.
AZ049	Zhao, J. Goss, W. M. Diamond, P.	Zeeman effect in H20 masers. 1.3 cm line.
GM003	Matveyenko, L. (ISR, USSR) Baath, L. (Chalmers, Onsala) Mantovani, F. (Bologna) Nesterov, N. (USSR) Padrielli, L. (Bologna) Rantakyro, F. (Chalmers, Onsala)	Superluminal radio sources at meter wavelengths. 90 cm, single antenna VLBI.
UA001	Andre, P. Phillips, R. (Haystack) Lestrade, J-F. (JPL)	Young magnetic stars.
UH001	Hough, D. (Trinity) Zensus, J. Vermeulen, R. (Caltech) Readhead, A. (Caltech) Porcas, R. (MPIR, Bonn) Rius, A. (NASA/INTA)	The search for superluminal motion in very weak nuclei of double-lobed quasars: 3C 204, 0839+616, 3C 205, and 3C 175. 3.6 cm, phased array MKIII VLBI.

E. THE VERY LONG BASELINE ARRAY (INTERIM OPERATIONS)

No.	Observer(s)	Program
BB002	Brown, R. Benson, J.	The apparent structure of Sgr A*.
BF001	Frail, D. van Langevelde, H. (Leiden) Habing, H. (Leiden) Cordes, J. (Cornell)	Angular broadening measurements of OH masers. 20 cm, phased array VLBI.

No.	Observer(s)	Program
BF003	Fiedler, R. (NRL)	Observations of Cygnus X-3.
BG003	Ge, J. (NMIMT) Zensus, A. Owen, F.	3C 317 compact core. 20 cm, single antenna VLBI.

F. SCIENTIFIC HIGHLIGHTS

Green Bank

New Receiver for 140-ft Telescope - The highlight this quarter for NRAO-Green Bank was the successful use of a new receiver covering 25-35 GHz. Although the efficiency of the telescope is not high in this band, its beam remains intact and its pointing permits useful observations.

First uses of the new receiver were for molecular spectroscopy. A team led by Henry Matthews of the JCMT detected sulfur monoxide, SO, and used it as a probe of denser parts of molecular clouds. The spatial distribution of SO traced where neutral-neutral reactions occur.

Bill Irvine, UMass, and an international team of collaborators, detected C_2O. This detection may help evaluate whether larger molecules are produced in gas phase reactions or on interstellar grains.

Morley Bell and colleagues from the Herzberg Institute of Astrophysics detected the J=24-23 transition of HC_7N. They also searched for ^{13}C isotopomer transitions of this same molecule.

Socorro

Rapidly Moving Young Pulsar? High resolution VLA observations have made possible an exciting new reinterpretation of the unusually shaped galactic radio source, G5.4-1.2. VLA B-configuration images reveal a compact, highly polarized, flat-spectrum radio nebula extending beyond the western periphery of G5.4-1.2. With the compact source isolated in the 28" x 13" synthesized beam, pulsed emission with a period of 124 msec was detected, verifying that the pulsar PSR 1758-24 and the compact source are associated. The period is 40 μsec longer than the 1985 discovery period. If the rapid spin-down rate is confirmed, PSR 1758-24 could be one of the most energetic galactic pulsars. The implied age of the pulsar is 1.4×10^4 years--short enough such that, if it originated at the center of G5.4-1.2, the pulsar's proper motion would be easily detectable with future VLA images.

Investigators: D. Frail, NRAO; S. Kulkarni, Caltech

Transient Source Near Galactic Center

VLA observations of the galactic center were taken in the recent C and D configurations for the purpose of monitoring the total flux density from Sgr A*. When some of the data was imaged in mid-March, an unusual source approximately 30 arcseconds

from Sgr A* was detected on the December 28 map that was not present on the December 11 map. The new point source reached its peak flux density of 231 mJy at 8.4 GHz on January 20 and has declined since. The source has an average spectral index between 8.4 GHz and 22 GHz of -0.9, decreasing with increasing frequency. The transient source had almost become undetectable by mid-March, but an April 3 map shows it to be rising again at 15 GHz. The location of the source is roughly coincident with a broad ammonia emission peak in a molecular cloud near the galactic center.

Investigators: J. H. Zhao, NRAO; D. A. Roberts, Oklahoma; W. M. Goss, NRAO; D. A. Frail, NRAO

Tucson

Detection of Nitrous Oxide (NO) in the Earth's Atmosphere

Mesospheric NO has been detected at the 12 m in the 1.3 mm band using the new SIS receiver. NO and NO_2 play a dominant role in the catalytic destruction of ozone (O_3) in the earth's atmosphere. Chemical reactions affecting the abundance of ozone in the earth's atmosphere are of great importance since ozone shields the earth from solar ultraviolet radiation.

The abundances of NO and NO_2 are expected to show diurnal variations, with NO being the dominant nighttime species and NO the daytime species. NO combines with O_3 to form NO_2. Neither NO nor NO_2 have ever been observed before in the earth's mesosphere, which lies 50-90 km above the earth's surface.

Investigators: R. T. Clancy (LASP); D. O. Muhleman (Caltech)

SiN has been detected in the circumstellar envelope of IRC 10216 by means of its N = 6-5 and 5-4 transitions (two spin-doubled components in each case) at 218 and 262 GHz. Line profiles are flat-topped, indicating an outer-envelope distribution. In a C-rich environment such as IRC 10216, Si compounds involving carbon and nitrogen are expected, and SiN is the first silicon-nitrogen molecule detected. The abundance of SiN relative to that of the previously known compound SiC_2 is given by $SiN/SiC_2 \approx NH_3/C_2H_2$, indicating that SiN is formed by reaction of Si^+ with NH_3. Since both NH_3 and C_2H_2 are prominent products of thermochemical-equilibrium chemistry, which applies in the dense inner core, it appears that an efficient means of transporting silicon to the outer envelope must operate without it being adsorbed on grains. The likely carrier is SiH_4, which photodissociates to SiH_2 and thence to Si or Si^+.

Investigator: B. E. Turner

G. PUBLICATIONS

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

H. CENTRAL DEVELOPMENT LABORATORY

Amplifier Development

We have experienced problems with manufacturing 38-45 GHz amplifiers due to the fragility of the gate pads of the ROHM Research MODFET's. After trying several possible solutions to this problem, we redesigned the amplifier circuits. A new version of this amplifier will be tested early in April. The production and testing of 320 MHz, 610 MHz, 1.2-1.8 GHz, and 26-36 GHz amplifiers continued. Also, production of the 12-18 GHz amplifiers has been started.

A summary of amplifier deliveries in this quarter is given in the table below:

FREQUENCY BANDS	NUMBER OF AMPLIFIERS	COMMENTS
320 MHz	12	Room temp. amplifiers
610 MHz	12	Room temp. amplifiers
1.2-1.8 GHz	9	
26-36 GHz	2	
38-45 GHz	2	
Grand Total	37	

Superconducting (SIS) Millimeter-Wave Mixer Development

Millimeter-wave work in Charlottesville this quarter has focused largely on construction of receiver inserts for the new multiband SIS receivers being installed on the 12-m telescope:

4-mm band: Two spare receiver inserts for 68-90 GHz are almost complete. At present these use a slightly modified version of the successful 90-120 GHz mixer.

3-mm band: Two receiver inserts for 90-115 GHz have been delivered to Tucson. DSB receiver noise temperatures are between 27 K and 42 K. Two spare inserts for the same band are almost complete.

1.3-mm band: Two more 200-260 GHz receiver inserts have been completed and are now available as spares.

Work continues on the design of two new mask sets containing SIS mixers to be fabricated by A. Lichtenberger at UVA. The plans have been changed since the last quarterly report: One wafer will contain devices primarily for operation at 200-300 GHz, including *tunerless* mixers (*i.e.*, requiring no mechanical tuning) for the eight-beam receiver, and a few small chips for 130-170 GHz. The second mask set will contain small chip and integrated (tunerless) designs for the 130-170 GHz bands.

During this quarter we have built (or rebuilt) and tested a total of four SIS mixers operating from 68-260 GHz. In addition, two of our (UVA) SIS chips have been installed in mixers for R. Blundell of the Harvard/Smithsonian Submillimeter Array.

OVLBI Earth Station Project

Preparations for holographic measurement of the 45-ft antenna's surface were completed, and initial data were taken using the SATCOM-K1 satellite at 11.9 GHz. These measurements were just beginning to be analyzed at the end of the quarter. Prior to installing the holography receiver, additional data was taken with the 15 GHz test receiver to verify the efficiency and pointing. The latter was found to be significantly worse in the daytime than at night, although still within acceptable limits.

The technical team was augmented by the arrival of a software engineer (D. Varney) on February 4 and a microwave engineer (W. Shillue) on February 19. This brings the group to four (with Technical Specialist D. Burgess and Project Engineer L. D'Addario), and leaves one open position for a digital engineer.

Serious efforts were begun to address critical technical issues in the design. These include the feed/optics arrangement, the choice of control computer and its operating system, and the details of the precise timing transfer to the spacecraft. Several options for the feeds are being studied in detail, with the strongest effort so far on a single-feed cassegrain system. Several computer operating systems are being evaluated; we have been fortunate to obtain evaluation copies from three major vendors for our temporary use at no cost.

NASA funding for this project is set at $1.0M for FY1991. The transfer of this amount to NSF was completed in February. With carryover funds from 1990, this provides $1.15M for use during CY1991. This will allow the purchase of some major hardware, including the hydrogen maser and one VLBA recorder. Discussions with vendors and preparation of formal procurement specifications were begun during the quarter.

Our next major milestone is to be a Preliminary Design Review, tentatively scheduled for July 2. Feasible designs (but not necessarily final designs) and accurate costs should be available for all components of the station by then.

I. GREEN BANK ELECTRONICS

Green Bank Telescope

Work continued on various aspects of the GBT optics configuration. Computer aided design programs for feeds were installed. Investigations into possible light-weight feed fabrication techniques were continued. A visit was made to a potential vendor for the Gregorian feed window material. Discussions on past experience, measured RF data and mechanical aspects were undertaken. The plan for designing the window now consists of obtaining samples of the most likely materials and performing tests to look for problems due to scattering, reflections, or absorption. Material for a full size window will then be selected and installed on the Indoor/Outdoor Receiver Test Building

in Green Bank to gain experience with mechanical aspects of the window and to do further performance tests.

Since it is likely the GBT IF signals will be transmitted over fiber optics, it is important to gain operational experience with these systems. Components have been installed for a fiber optics IF link for the 140-ft Cassegrain receivers. Comparison of spectral baselines and other characteristics over this link and over our normal coaxial cables, while astronomy programs are underway, will allow us to identify potential problems. Initial tests show no significant differences between the coax and IF lines.

Progress was also made in several areas of the active surface design. Life testing of prototype actuators was begun. At this time, the accelerated life tests are 75 percent complete, and there still remain three promising prototype actuators. The accuracy and repeatability of the position transducers (LVDT's) used in the active surface are critical in properly setting the surface under "open-loop" conditions. A precision test fixture for evaluating the LVDT's is now in use and producing data with better than 25 micron repeatability. Also a commercial freezer has been modified to test the repeatability of the LVDT's at various ambient temperatures. Some of the sample LVDT's and electronics have been evaluated. Several refinements of a distance measuring system that will be used for pointing and surface measurement were completed. A temperature correction for the index of refraction has been added to the data processing. Investigation of the possible presence of bulk atmospheric effects began. For example, the method will fail if the average air temperature over the path to one target differs by 1° C from the path to another target. Initial measurements show that this is not a problem. Work is now progressing on the design of an instrument that will be close to the final version.

Autocollimators will be used on the GBT to measure and correct for pointing errors introduced by the foundation, track and alidade structure. During this quarter, a preliminary design for a range with which to characterize the autocollimators was completed.

A holographic technique will be used to measure the surface accuracy of the completed GBT. During this quarter, design requirements have been established and possible designs studied.

Work has begun on the LO system design. Measurements of phase noise and other characteristics of several available synthesizers were done, and research into commercial synthesizers started. Performance requirements are being formulated.

Interferometer Upgrade

The USNO is funding the upgrade of the Interferometer to improve their time-keeping capabilities. As part of this upgrade, the three antennas have been outfitted with cooled S/X receivers. Receivers for 327 MHz and 610 MHz have been added to the 85-3 antenna. The 85-3 telescope is operated as a VLBI terminal in conjunction with other USNO antennas and as a single dish pulsar timing antenna. The 85-1 and 85-2 antennas are operated as a connected interferometer to continue a long-term flux monitoring program. Another aspect of the upgrade is the provision of a data

acquisition terminal for the VLBI data. This terminal will consist of a VLBA data acquisition rack, longitudinal recorder, and control computer. Also, NRAO is presently constructing a second VLBA terminal and an S/X receiver for a USNO VLBI antenna in Hawaii which is to be used in conjunction with the 85-3 antenna.

During this quarter, the VLBA data acquisition rack was moved to the interferometer control building for further testing and initial observations. A counter/computer interface that forms the final stage of a system to monitor the cable length between the 85-3 S/X receiver and the control building was completed and is being tested. Construction of baseband converters for the second VLBA data acquisition rack continued. Construction of the S/X receiver was begun.

140-ft Cassegrain Receivers

The current 140-ft cassegrain receiver systems use parametric upconverters and 18-25 GHz masers to cover the 5-25 GHz frequency range. A project is underway to replace the upconverters with HEMT amplifiers and to also extend the frequency range to greater than 30 GHz. The masers will be retained because of their significantly superior noise performance over current HEMT technology. The first step in this project is to redesign the LO for frequency flexibility to 35 GHz.

During this quarter testing of components for the LO system and 32 GHz upgrade was completed. The system was installed and several observations have been made. The telescope beam seems to be reasonably well behaved at this wavelength. The sidelobes are higher than at K band, but there is still only one main beam. In the best parts of the band, system temperatures of 75 K have been measured.

Miscellaneous

The fifth VLBA S-band receiver was constructed during the quarter. C-band receiver No. 8 was shipped; No. 9 is awaiting shipment; Nos. 10 and 11 (the final two) are in the final testing stages. The second VLBA 43 GHz receiver is ready to ship and the third is assembled and being tested.

J. 12-M ELECTRONICS

Receiver Status

During this quarter, the 200-270 GHz SIS receiver has been in routine use. Noise temperatures as low as 80 K DSB at 230 GHz have been measured.

Completion of the new 68-115 GHz receiver has been delayed yet again due to pressure of maintenance work at the telescope. We hope to test this new receiver on the telescope within the next couple of months.

The upgrade of the 230 GHz 8-beam receiver to SIS continues. The dewar is now complete and ready for testing.

The Hybrid Spectrometer

This instrument has been successfully interfaced to the new control system and is now in routine operation. Upgrades to give the instrument greater versatility will be undertaken during the next year.

K. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam and pointing errors then limit the achievable dynamic range.

At high frequencies the pointing errors become a significant fraction of the primary beamwidth so the source being imaged is affected directly. For example, at 44 GHz a 20" pointing error would cause a 30 percent change in amplitude. Solar-induced tilts, which formerly dominated our pointing errors, have been greatly reduced through external insulation of the antenna yoke and base support.

Pointing problems, such as an antenna tilt caused by constant wind force, may be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Testing of the stability of the redesigned tilt-meter units show a long-term stability of about 3 arcseconds. Eight have been fabricated and tested. Two VLA antennas have been outfitted with two sets of tilt-meters on each antenna. In order to provide still more information about these two antennas, 32 temperature probes will be installed at various locations. Further system testing will continue through 1991.

RFI Improvements

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

Four RFI enclosures for the vertex mounted "B" racks have been purchased and tested. These RFI enclosures eliminate the remaining antenna-generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. The remaining twenty-four RFI enclosures have not been procured due to an increase in cost by a factor of two. An in-house design for a new RFI enclosure is complete. Construction of a prototype was completed in the third quarter of last year, and lab testing of this enclosure is complete. The unit has been installed on an antenna, and system testing is under way. Three more units were ordered and received, with one more unit installed this quarter.

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 resolution is desirable.

The VLA 18-21 cm wavelength receiver 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 which prevents polarization splitters from being cooled.

The VLA L-band receiver system will be upgraded using the VLBA design, viz., dual polarization HEMT amplifiers with circular polarizers all in an independent cryogenic dewar. Presently six VLA antennas have the improved VLBA style receiver installed. Three more of the new front-end systems are now in the assembly process. By the end of this year, ten VLA antennas should have the improved VLBA style receivers.

L. AIPS

The AIPS project has been formally divided into three major efforts. The first is the support for the current software (which is now known as AIPS1). The second is the enhancement of AIPS1 to deal with the input and calibration of VLBI data, especially for the VLBA project. The last is the development of a new software system (to be known as AIPS2).

AIPS1 is now fully available on two new workstation platforms. The IBM RS6000 and the DECstation were used for data reduction by observers in Charlottesville in 1990. Support for these workstations was made generally available in the 15JAN91 release of the software. Also in the 15JAN91 release are the new versions of the numerically intensive routines (Q-routines). These have been modified so that complete processing of images up to 4k x 4k pixels in size are fully supported on any computer architecture.

A new table format will be used to handle the data from the VLBA correlator. The specification for these tables is complete. The task to write these tables is complete; the task to read the tables into AIPS1 internal format should be complete next quarter.

The development of AIPS2 has already started. An object-oriented approach will be used for the system level support routines. These will be specified in the Eiffel language. The choice of language for final implementation has not yet been made. Once the kernel routines are specified, it is planned that the code development will proceed in collaboration with many radio observatories worldwide.

M. VLA COMPUTER

In the online systems area, data flagging criteria have been reviewed and made stricter in an effort to attack the "first record" problem.

Improvements were also made in the robustness and ease-of-use of monitor data retrieval programs. Investigation and preparation for a ModComp operating system upgrade, which is required for future VLA site networking plans, was begun, and planning for the correlator control system upgrade continued. Source change timing has been made more predictable.

The Multinet TCP/IP networking package has been installed on the VAX 11/750 at the VLA site, and we now have a TCP/IP connection between this system and the VLBA MicroVAX at the AOC. This has greatly improved the reliability of delivering observe files to the site, and will also be needed to connect the site Ethernet, currently being installed, to the existing AOC network and the Internet.

The use of desktop workstations at the VLA continues to increase. In January, a SPARCstation 2 with a gigabyte of private disk space was installed, and has been in continuous use, largely for AIPS data reduction.

Several of the research and support staff have made use of this system, and of the IBM RS/6000-320 installed at the end of 1990. In addition, four Sun SPARCstation IPC desktop color workstations have been ordered, and an IBM RS/6000-530 loaned to us by IBM, to model the proposed Array Computing Plan. This is an important step in determining whether the plan is viable with current technology. Several of the VLA computer staff are heavily involved in the committees to evaluate available products and provide preliminary specifications for the fall procurement.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The first six antennas are outfitted and operable. The Pie Town, NM, Kitt Peak, AZ, and Los Alamos, NM antennas routinely participate in Network observations. The Fort Davis, TX antenna will be fully staffed to support Network observations starting in June 1991. The North Liberty, IA antenna was declared operable September 1990. The Owens Valley, CA antenna was declared operable in February 1991. Antenna erection at the Hancock, NH site is largely complete, with final assembly scheduled for completion in June 1991. Outfitting of the Brewster, WA antenna was recently completed, and is scheduled to be operable in May. At St. Croix, VI the antenna erection has started. At Mauna Kea, HI antenna foundation and site preparation construction are underway.

Electronics

In addition to completing front ends, a major task of the electronics division for 1991 will be completion of the remaining converter modules, and spare units for all modules. At least three spares for each type of module are required to allow for maintenance with a minimum of down time when failures occur. Also, some of the earlier

modules require retrofits in cases where testing in the field has shown a design modification is desirable. Most of the module construction and retrofitting will be completed by the end of 1991. A total of 13 racks of type D (Data Acquisition) will be required for the VLBA. These comprise one for each antenna, one for recording data at the VLA, and two laboratory systems. Nine of these racks had been completed by the end of 1990, and the remaining ones will be finished by the end of this year.

During this quarter, a large part of the remaining components required have been procured or are on order. Front ends for 330/610 MHz have now been completed through No. 6, for 2.3 GHz through No. 5, for 8.4 GHz through No. 10, and the third front end for 43 GHz is under test. D-rack No. 11 is in the final stages of construction. Parts for the first new design, 15 GHz front end have been received and construction has been started.

Data Recording

The second production run of recorder units are constructed and mostly shipped to NRAO sites. Units Nos. 15, 18, and 20 function as acquisition units, but remain at Haystack awaiting installation of playback electronics, and subsequent testing prior to shipment to Charlottesville for use with the VLBA correlator. Procurement of parts for the third run, units No. 22 - No. 32 is well underway. Analysis, engineering, and quality control test development work for critical parts of the recording system, such as headstacks, thin tape, and tape-head optimum pressure, continues at Haystack.

Monitor and Control

During fourth quarter 1991 our primary concern was to make the vxWorks version of the array control software reasonably reliable. A special effort was made to make the station clock more reliable. At the beginning of the quarter, it frequently gained or lost a second, especially at station computer reboots. It is believed that the April software update will essentially solve these problems.

The endemic communications problems appear to be much more under control. We have sequentially implemented Internet communications to the Los Alamos, North Liberty, Pie Town, and Kitt Peak antenna sites. The first three sites are now working reliably. Fort Davis and Owens Valley are in the process of being connected to the Internet. Kitt Peak suffers occasional PTUA power outages which sometimes effects all PTUA telephone communications to the mountain, including the Internet, when the microwave link between Tucson and the Mountain goes down. We must carefully watch the reliability of communications to Kitt Peak. A cellular telephone for the modem used in backup control of the antenna is under consideration for this site.

The handling of station specific data (ranging from station location to the operating parameters of the tape transports and the subreflector settings for the various bands) has been altered to store the parameters at the stations, on local disk, and to document their values in the monitor data stream. Previously, they were compiled into the programs, which proved intolerably clumsy.

Work is continuing on array control overview screens. An extremely primitive screen is now available to display the data checker status of all stations. Software

support for the Data Quality Analyzer portion of the MkII controller device has been built into the screen which communicates with it. Software support for the VLBA tape format has been added although checkout is incomplete because of difficulties with the formatter firmware. A proposal has been made for the contents of database tables which will eventually be used to provide the control scripts for the correlators, and some work has begun on the programs which will insert the data from the monitor data stream into them.

Correlator

Construction of correlator and playback interface hardware neared completion in this quarter. The three outstanding module sets were received from the assembler. Final assembly--insertion of FX chips, microprocessors, and programmed logic elements--and module checkout proceeded more rapidly than expected but nevertheless occupied much of the quarter. By the close of this period, all the Track Recovery, FFT, and Cross-Multiplier/Accumulator modules (including spares), and approximately half the Deformatter modules, had been checked out.

Completion of firmware for the on-board microprocessors in both the Track Recovery and Deformatter modules has required substantially more effort than anticipated. These tasks are now critical for system tests of the playback interface.

Assembly and checkout of controllers for the FFT module bins was completed, except that final insertion of floating-point arithmetic IC's in two of these units has been delayed pending receipt of adapters. The Integrator was wire-wrapped, and partially assembled and checked out. Development of the Output Filter progressed to the stage of detailed design. Options for transmitting data from the Filter to the computer system were studied, and a tentative solution chosen.

Construction of all racks and bins was completed, including assembly and commercial wire-wrapping of backplanes with twisted pairs, and installation of power supplies and bus bars. One of the four racks was cabled for power, and control and clock signals; only the data cabling between bins remains incomplete. On the last working day of the quarter, power was successfully applied in this rack.

Hardware construction has now advanced sufficiently that the original phased completion scheme has become superfluous, as anticipated in earlier reports. Accordingly, the group has abandoned the 7-station, 2-channel subset correlator objective, and aims instead to deliver the complete 20-station, 8-channel configuration, on the same time scale as originally planned for the subset.

The correlator control system reached an important milestone, the first formal release of the real-time software. While not yet an operational version, the release integrated substantially complete initial versions of five major real-time subsystems, as well as a wide variety of support and utility code. This software has all been tested quite thoroughly, including actual control of the two playback drives which have been delivered thus far, but in general with only limited access to playback interface and correlator hardware thus far.

Design of the data archive and distribution system has started. This effort includes both a market survey of recording device options and the architectural design of the associated tasks. Procurement of DAT drives for the archive was initiated.

Data Processing

Although significant manpower has been diverted from the postprocessing system to the development of a second generation of AIPS, there has been considerable progress in the area of software needed for VLBA postprocessing. Several major projects have come to fruition:

- MK3IN: a task that reads "A" tapes from a MkIII correlator and provides our group with VLBA like data. This is a much awaited capability for the AIPS processing of MkIII data.

- Development and debugging of the fringe-fitting and calibration software dealing with MkIII/VLBA style data. This provides us with a method of deriving the true single and multi-band delays simultaneously, a necessary step for the calibration of VLBA data.

- IBLED: an interactive TV based editor, most useful for VLBI data, and edits data on a baseline-by-baseline basis. This task now works efficiently for VLBA style data.

- Several tasks for the calibration of spectral line VLBI data, a major debugging effort, mostly in the area of multi-IF and polarization spectral line data-an area of especial interest for the VLBA.

- Several utility tasks for the display and diagnosis of VLBI data.

In addition, much effort has been devoted to the definition of a FITS format for the VLBA distribution/archive system. This has now been distributed widely (internationally) for comments. Routines to write this format from AIPS have been developed. The FITS reader is now under development.

O. PERSONNEL

New Hires

Ravindra, D. K.	Visiting Elec. Engineer I	01/07/91
Ge. J. P.	Asst. Scientist, Socorro Operations	01/02/91
Varney, D. M.	Sci. Programming Analyst	02/04/91

Terminations

Usowicz, J. B.	Visiting Scientist	01/18/91
Morris, D.	Visiting Scientist	02/28/91
Coe, J. R. (deceased)	Elec. Engineer I	01/27/91

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