NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January 1 - March 31, 1990

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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 1990.

	140-ft	12-meter	VLA
Scheduled observing (hours)	1935.00	1772.25	1624.6
Scheduled maintenance and equipment changes	193.5	116.25	264.6
Scheduled tests and calibrations	127.25	261.50	261.6
Time lost	103.75	366.25	78.0
Actual observing	1831.25	1496.00	1546.7

B. 140-FOOT TELESCOPE

The following line programs were conducted during the quarter.

No.	Observer(s)	Program
B-492	Bell, M. (Herzberg) Feldman, P (Herzberg) Matthews, H. (Herzberg)	Spectral survey of IRC+10216 over the range 22.0-24.5 GHz.
B-524	Bell, M. (Herzberg) Avery, L. (Herzberg) Feldman, P. (Herzberg) Matthews, H. (Herzberg)	Studies at 17.5-24.5 GHz of heavy molecule chemistry in shocked and unshocked gas in Orion.
B-492	Bell, M. (Herzberg) Feldman, P. (Herzberg) Matthews, H. (Herzberg)	Spectral survey of IRC+10216 over the range 22.0-24.5 GHz.
B-525	Bell, M. (Herzberg) Seaquist, E. (Toronto)	Observations at 17.25 GHz of redshifted C_3H_2 in absorption against NGC 1275.
B-533	Bell, M. (Herzberg) Seaquist, E. (Toronto)	Observations at 22.235 GHz to examine the dust lane and nuclear region of Centaurus A.
C-257	Clark, F. (Air Force Geophys. Lab) Mann, P. (Kentucky) LaHaise, W. (Kentucky)	Observations of 2 cm H_2CO infrared objects.

No.	Observer(s)	Program
K-323	Koempe, C. (Herzberg) Mann, P. (Kentucky) LaHaise, W. (Kentucky)	Search at discrete frequencies over the range 18.5-23.6 GHz for NH_3 emission in the S247/S252 gas complex.
L-238	Lee, Y. (Leiden) Greenberg, J. (Leiden) Minn, Y. (Kyung Hee, Korea)	Study H_2CO at 2 cm to compare with CO data to establish dust correlation in dense dark clouds.
L-284	Madden, S. (Massachusetts) Brown, R. (Monash Univ.) Godfrey, P. (Monash Univ.) Henkel, C. (MPIR, Bonn) Irvine, W. (Massachusetts) Wilson, T. (MPIR, Bonn) Maddalena, R.	Time variability study of ammonia masers at 1.5 cm.
M-309	Mutel, R. (Iowa) Allen, J. (Iowa)	Survey of the galactic plane for 18 cm OH masers and confirmation of three newly discovered OH masers that are coincident with IRAS sources.
T-272	Turner, B. Rickard, L. J (NRL) Lanping, X.	Studies at 2 cm of H_2CO in Cirrus Clouds.
V-72	Vanden Bout, P. Brown, R.	Search in the range 21-23 GHz for CO emission in high-Z QSO's.
W-269	Wilson, T. (MPIR) Batrla, W.	Search at 18.2 GHz for the 2-1 line of HC_3N toward Cas A.
W-271	Williams, D. (Berkeley) Shuter, W. (British Columbia)	Search for the 17.5 GHz transition of H_2^+ in Jupiter and the interstellar medium.
W-280	Wootten, H. A.	H_2O monitoring in star-forming cores in Rho Oph.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
B-484	Backer, D. (Berkeley) Foster, R. (Berkeley)	Timing observations at 750-800 and at 1330 MHz of PSR 1821-24 and other millisecond pulsars.

No.	Observer(s)	Program
T-265	Taylor, J. (Princeton) Stinebring, D. (Princeton) Dewey, R. (JPL) Nice, D. (Princeton) Thorsett, S. (Princeton) Arzoumanian, Z. (Princeton)	Pulsar timing observations over the range 390-450 and 1355 MHz.
T-280	Taylor, J. (Princeton) Fruchter, A. (DTM) Stinebring, D. (Princeton) Nice, D. (Princeton) Thorsett, S. (Princeton)	Studies at 18 cm of the eclipsing millisecond pulsar in Terzan 5.

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

A - Arecibo 1000 ft	Me - Merlin
B - Effelsburg, MPIR 100 m	N - NRL Maryland Point 85 ft
E - Hartebeesthoek, South Africa	No - Noto, Sicily
F - Fort Davis 85 ft	Pt - Pietown 25 m
G - Green Bank 140 ft	R - Crimea, USSR 30 m
H - Hat Creek 26 m	Sa - Shanghai 25 m
I - Iowa 60 ft	So - Onsala 25 m
Jb - Jodrell Bank 250 ft	T - Torun 15 m
Km - Haystack 120 ft	Wn - Westerbork n = 1-14x26m
Kp - Kitt Peak 25 m	X - Itapetinga 20 m
Lb - Bologna 25 m	Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
A-31V	Abraham, Z. (Itapetinga) Zensus, A. Carrara, E. (Itapetinga) Unwin, S. (Caltech) Cohen, M. (Caltech) Nocholson, G. (Hartebeesthoek)	Time evolution studies of 3C 273 and 3C 279 at 2.8 and 6 cm, with telescopes B, Lm, No, Km, G, F, O, H. Pt, A, Mb, and E.
AH-48V	Lonsdale, C. (Haystack) Weedman, D. (Pennsylvania) Lonsdale, C. J. (Caltech) Smith, H. (UCSD)	Search at 18 cm for fringes from component A of the interacting galaxy system NGC 3690, with telescopes G, O, and Pt.
B-82V	Bartel, N. (CFA) Rogers, A. (MIT) Shapiro, I. (MIT)	Studies at 6 cm of the expansion and morphology of SN1979C, with telescopes B, Wn, G, O, Y_{27}, and A.

No.	Observer(s)	Program
B-100V	Biretta, J. Cawthorne, T. (Brandeis) Reid, M. (CFA) Gabuzda, D. (JPL)	Observations at 18 cm of the M87 nuclear jet, with telescopes B, So, Lm, Wn, Jb, K, G, F, O, Y_{27}, A, and Pt.
B-101V	Benz, A. (ETH, Zurich) Isliker, H. (ETH, Zurich) Alef, W. (MPIR, Bonn) de Vicente, P. (MPIR, Bonn)	Studies at 18 cm of M-dwarfs, with telescopes B, J, G, O. Y_{27}, and A.
B-102V	Bartel, N. (CFA) Rogers, A. (MIT) Shapiro, I. (MIT)	Studies at 18 cm to determine to what degree SN1979C is circularly symmetric, with telescopes B, Wn, G, O, Y_{27}, and A.
C-56V	Cordes, J. (Cornell) Gwinn, C. (UCSB)	Astrometry at 18 cm of the binary pulsar 1913+16, with telescopes B, G, O, Y_{27}, and A.
G-63V	Gwinn, C. (CFA) Mutel, R. (Iowa) Cordes, J. (Cornell) Moran, J. (CFA) Clegg, A. (CFA)	Observations at 18 cm of OH maser scattering disks in W49N, with telescopes B, G, F, O, Y_{27}, A, Pt, Kp, and A.
H-48V	Hough, D. (JPL) Readhead, A. (Caltech)	Measurements of superluminal motion at 2.8 cm in weak nuclei of double-lobed quasars 3C 208, 3C 249.1, and 3C 247, with telescopes B, Km, G, and Pt.
H-55V	Hummel, K. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Quirrenbach, A. (MPIR, Bonn) Schalinski, C. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Rioja, M. (MPIR, Bonn) Johnston, K. (NRL)	Studies at 6 cm of the "bridge" in the S5 quasar 0153+744, with telescopes B, Wn, So, Lm, Jb, R, No, Km, G, F, O, H, N, Pt, Kp, and La.
L-57V	Lonsdale, C. (Haystack) Phillips, R. (Haystack) Barthel, P. (Groningen) Muxlow, T. (Manchester)	Observations at 18 cm of the hotspot in 3C 263.1, with telescopes B, Jb, G, and Y_{27}.

No.	Observer(s)	Program
M-110V	Mutel, R. (Iowa) Spangler, S. (Iowa) Molnar, L. (Iowa) Cordes, J. (Cornell) Gwinn, C. (UCSB) Fey, A. (Iowa)	Studies at 18 cm of interstellar scattering effects of sources exhibiting these properties, with telescopes B, Lm, Wn, Km, G, F, O, Y_{27}, Pt, and A.
M-111V	Mutel, R. (Iowa) Jie, D. (Iowa) Phillips, R. (Haystack)	Monitor the core of Bl Lac at 2.8 cm, with telescopes B, Lm, No, Km, G, F, O, H, Pt, and Sa.
M-112V	Mutel, R. (Iowa) Baum, S. (NFRA) O'Dea, C. (NFRA)	Multifrequency maps at 6 and 18 cm of the three compact doubles at 6 and 18 cm, with telescopes B, Lm, So, Wn, Jb, No, Km, G, O, Y_{27}, Pt, and Kp.
P-92V	Pauliny-Toth, I. (MPIR, Bonn) Alberdi, A. (IAA, Audalucia) Zensus, A. Cohen, M. (Caltech)	Monitor at 2.8 cm quasar 2134+004, with telescopes B, Lm, R, Km, G, F, O, H, Pt, and Mb.
P-01V	Phillips, R. (Haystack) Feigelson, E. (Penn State) Lonsdale, C. (Haystack)	Investigation at 6 and 18 cm of the compact nonthermal emission around naked T Tauri stars, with telescopes B, Jb, G, O, Y_{27}, and A.
R-49V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Cawthorne, T. (Brandeis) Wardle, J. (Brandeis) Gabuzda, D. (JPL)	Survey at 6 cm of the linear structure of the Pearson-Readhead Sample, with telescopes B, Lm, So, Wn, K, G, F, O, and Pt.
R-50V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Cawthorne, T. (Brandeis) Wardle, J. (Brandeis) Gabuzda, D. (JPL)	Measurements at 6 cm of the evolution of the linear polarization structures of superluminal sources, with telescopes B, Lm, So, Wn, K, G, F, O, and Pt.
R-51V	Readhead, A. (Caltech) Wilkinson, P. (Manchester) Xu, W. (Caltech) Pearson, T. (Caltech) Lawrence, C. (Caltech) Herbig, T. (Caltech)	Large snapshot survey at 6 cm of active galactic nuclei, with telescopes B, Lm, So, Wn, Jb, No, K, G, F, O, H. Pt, Kp, and La.

No.	Observer(s)	Program
V-3V	Vermeulon, R. (Caltech) Schilizzi, R. (NFRA) Spencer, R. (Manchester) Romney, J. Preston, R. (JPL) Feges, I. (Budapest)	Observations at 18 cm of the radio spectrum of the jets of SS433, with telescopes Km, G, F, O, Y_{27}, A, Dm, and Pt.
W-57V	Wehrle, A. (Caltech) Unwin, S. (Caltech) Zensus, A. Cohen, M. (Caltech)	Monitor at 2.8 cm the superluminal motion in 3C 345, with telescopes B, L, R, No, K, G, F, O, H, and Pt.
X-55V	Massi, M. (Arcetri)	

The following continuum program was conducted this quarter.

No.	Observer(s)	Program
C-255	Condon, J. Broderick, J. (VPI&SU) Seielstad, G.	Sky survey at 4.85 GHz covering 45 < = +5 dec.

C. 12-METER TELESCOPE

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-94	Adler, D. (Illinois) Allen, R. (Illinois) Lo, K. (Illinois) Sukumar, S. (Illinois)	Study of the structure of the interstellar medium in the spiral galaxy M83.
A-96	Andre, P. Leous, J. (Penn State) Montmerle, T. (Saclay, France) Cabrit, S. (Saclay, France)	Extensive search for outflows around low-luminosity young stellar objects in L1495.
A-97	Andre, P. Cabrit, S. (Saclay, France) Edwards, S. (Massachusetts) Bertout, C. (IAP, Paris)	Study of molecular flows and wind cavities around T Tauri stars.
A-98	Alloin, D. (Paris Obs.) Antonucci, R. (UCSB) Barvainis, R. (Haystack) Gordon, M.	CO observations of radio-quiet quasars.

No.	Observer(s)	Program
B-529	Buhl, D. (GSFC) Chin, G. (GSFC) Goldstein, J. (NASM)	Observations of CO in the atmospheres of Venus and Jupiter at 345 GHz.
C-262	Clancy, R. (Colorado) Muhleman, D. (Caltech)	CO/temperature studies of Venus and Mars.
G-309	Gordon, M. Walmsley, C. (MPIR, Bonn)	Investigation of the population processor in atomic hydrogen in galactic HII regions.
G-311	Gordon, M. Martin-Pintada, J. (Yebes Obs.)	Monitoring program for the RRL maser in MWC 349.
G-312	Gordon, M.	Follow-up to a search for molecular gas in elliptical galaxies.
H-266	Hurt, R. (UCLA) Turner, J. (UCLA)	CO (1-0) and CO (2-1) mapping of the starburst galaxy Maffei 2.
H-267	Ho, P. (CFA) Szczepanski, J. (MIT) Ho, L. (CFA)	Study of molecular cloud interactions in the galactic center.
K-319	Kutner, M. (RPI) Verter, F. (GSFC)	Study of the response of GMCs in M31 to the spiral shock.
L-241	Loren, R. (Unaffiliated) Wootten, H. A.	Study of molecular abundances in oxygen-rich cores in the rho Oph cloud.
M-299	Meyer, D. (Northwestern) Hawkins, I. (Berkeley)	Study of excitation of interstellar CN toward HD 21483.
M-305	Martin, R. (Arizona) Ho, P. (CFA) Turner, J. (UCLA)	J=3-2 study of hot gas in extragalactic nuclei.
M-307	Maizels, C. (UCLA)	A search for CO in carbon stars.
S-326	Szczepanski, J. (MIT) Ho, P. (CFA)	Study of gas feeding of the galactic center region.
S-332	Sage, L. (NMIMT)	^{12}CO observations of distance-limited sample of spiral galaxies.
S-334	Sage, L. (NMIMT) Shore, S. (NMIMT) Solomon, P. (SUNY, Stony Brook)	Dense molecular gas in nearby spiral galaxies: Further CS observations.

No.	Observer(s)	Program
T-256	Turner, B. Lubowich, D. (Hofstra)	Study of mass loss from super Li-rich stars and the galactic lithium problem.
T-274	Turner, B. Lubowich, D. (Hofstra)	Tests of grain-shock interactions in the IC 443 supernova remnant.
T-275	Turner, B.	Confirmation of D_2CO and NHD_2 in Orion: A test of grain theories.
T-279	Turner, B.	A search for circumstellar SiH_2.
V-71	Vanden Bout, P.	CO (J=2-1) mapping of the S88B molecular cloud.
W-270	Westpfahl, D. (NMIMT) Sage, L. (NMIMT)	CO observations near the center of M81.
W-272	Wootten, H. A. Mangum, J. (Virginia) Loren, R. (Unaffiliated)	Study of H_2CO in young star-forming clumps in the rho Oph molecular cluster.
W-273	Wootten, H. A. Mangum, J. (Virginia) Loren, R. (Unaffiliated)	H_2CO: The K = 0, 1, 2, 3 lines for core structure determination.
W-275	Womack, M. (Arizona State) Ziurys, L. (Arizona State) Wyckoff, S. (Arizona State)	Study of nitrogen abundance in the ISM and constraints on conditions in the primitive solar nebula.
W-277	Wootten, H. A. Sahai, R. (Onsala)	Study of interrupted mass loss in AGB red giants: CO observations.
W-279	White, G. (Queen Mary College) Williams, P. (Queen Mary College) Parker, N. (Queen Mary College) Pinnock, S. (Queen Mary College)	Study of turbulence and fragmentary structure in molecular clouds.
Y-8	Yun, M. (CFA) Ho, P. (CFA)	Study of high-temperature and high-density molecular gas in M82.
Z-81	Ziurys, L. (Arizona State) Lis, D. (Massachusetts) Goldsmith, P. (Massachusetts) Steimle, T. (Arizona State)	A proposed 270-300 GHz spectral line survey of Sgr B2N and Orion-KL.
Z-84	Ziurys, L. (Arizona State)	Silicon chemistry in dense clouds: Searches for SiC.

D. VERY LARGE ARRAY

First quarter, 1990 was spent in the following configurations:

D configuration from: January 1 to January 29
AD configuraiton from: January 29 to February 12
A configuration from: February 12 to March 31

The following 143 research programs were conducted during the quarter.

No.	Observer(s)	Program
AA-110	Akujor, C. (Nigeria) Rao, A. (Kapteyn Lab)	1912-172--a flat spectrum double source. 3.8, 6 and 20 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2 and 6 cm.
AB-456	Burke, B. (MIT) Hewitt, J. (Princeton) Roberts, D. (Brandeis)	Monitoring Lens 0957+561. 6 cm.
AB-457	Brown, A. (Colorado) Bookbinder, J. (CFA)	Distance to the Taurus-Auriga star formation region. 6 cm.
AB-532	Bridle, A. Fomalont, E.	Polarimetry of lobes of 3C 288. 3.8 cm.
AB-552	Beckman, J. (IAC, Laguna) Cepa, L. (IAC, Laguna) Shaw, M. (Manchester) Pedlar, A. (NRAL) Vila, B. (NRAL)	Triggering by density waves in grand design spiral galaxies. 20 cm line.
AB-554	Byrne, R. (Florida) Gottesman, S. (Florida)	Dwarf galaxies out to a distance of 50 Mpc. 20 cm line.
AB-557	Brett, B. (Manchester) Beck, R. (MPIR, Bonn)	Magnetic field in NGC 2903. 20 cm.
AB-560	Barthel, P. (Kapteyn Lab) Schilizzi, R. (NFRA) Miley, G. (Leiden)	Core-dominated quasars at high redshift. 6 cm.
AB-561	Barthel, P. (Kapteyn Lab) Coleman, P. (Kapteyn Lab)	Radio-quiet QSOs, and the BAL QSO connection. 3.8 cm.

No.	Observer(s)	Program
AB-563	Baudry, A. (Bordeux Obs.) Wilson, T. (MPIR, Bonn) Walmsley, C. (MPIR, Bonn) Menten, K. (CFA) Johnston, K. (NRL)	J=5/2 and J=3/2 transitions of OH in W3(OH). 3.8 cm line.
AC-244	Carilli, C. (CFA) Perley, R. Dreher, J. (NASA, Ames) Bridle, A. Cotton, W.	Cygnus A. 3.8 cm.
AC-251	Curiel, S. (CFA) Raymond, J. (CFA) Rodriguez, L. (UNAM) Canto, J. (UNAM)	Spectral index of radio sources associated with molecular outflows. 2 cm.
AC-255	Cool, A. (Harvard) Ho, P. (CFA)	NH_3 condensations in the Orion KL Nebula. 1.3 cm line.
AC-260	Chambers, K. (John Hopkins) Baum, S. (NFRA) Miley, G. (Leiden)	Redshifted CO line emission from a radio galaxy at Z=3.8. 1.3 cm line.
AC-261	Cruddance, R. (NRL) Johnston, K. (NRL)	Radio maps of MSH-17-203. 6, 20 and 90 cm.
AC-262	Campbell, B. (New Mexico)	Radio emission from new young stellar objects. 6 cm.
AC-264	Condon, J. Broderick, J. (VPI&SU)	UGC galaxies. 6 cm.
AC-266	Coles, W. (Calif., San Diego) Rickett, B. (Calif., San Diego) Cornwell, T. Hankins, T. (NMIMT) Armstrong, J. (JPL)	Intensity scintillation and angular scattering of the inner solar wind. 3.8, 6 and 20 cm.
AC-268	Cordes, J. (Cornell) Gwinn, C. (UCSB)	Point sources near the binary pulsar 1913+16. 20 and 18 cm.
AC-269	Cordes, J. (Cornell) Weisberg, J. (Carleton College) Backer, D. (Berkeley) Foster, R. (Berkeley) Lundgren, S. (Cornell)	Astrometry of weak pulsars. 20 cm.

No.	Observer(s)	Program
AC-272	Catarzi, M. (Arcetri) Cesaroni, R. (MPIR, Bonn)	Water maser and disk structure in star forming regions. 1.3 cm line.
AC-273	Coleman, P. (Kapteyn Lab) Turnshek, D. (Pittsburgh) Briggs, F. (Pittsburgh)	Quadruply lensed quasar 1412+117. 3.8 cm.
AD-188	Drake, S. (SASC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (CFA) Linsky, J. (Colorado)	Variability of M supergiants: alpha orionis. 2 and 6 cm.
AD-239	Dubner, G. (IAFE) Arnal, M. (IAR, Buenos Aires) Winkler, F. (Middlebury College) Goss, W. M.	Eight SNRs. 20 cm.
AD-244	Dey, A. (Berkeley) van Breugel, W. (LLNL)	Images of radio-loud, far-infrared galaxies. 2, 6 and 20 cm.
AD-248	Dougherty, S. (Calgary) Taylor, A. (Calgary) Waters, L. (Western Ontario)	Be stars. 2 and 3.8 cm.
AE-63	Edelson, R. (Colorado) Begelman, M. (Colorado)	CFA Seyfert galaxies. 2, 6, and 20 cm.
AE-66	Engels, D. (Hamburger Sternwarte) Winnberg, A. (Onsala) Lindqvist, M. (Onsala) Walmsley, C. M. (MPIR, Bonn) Schmid-Burgk, J. (MPIR, Bonn)	Water maser emission in circumstellar shells. 1.3 cm line.
AE-67	Erickson, W. (Tasmania) Jacobson, A. (Los Alamos)	Ionospheric structure. 90 cm.
AF-177	Felli, M. (Arcetri) Churchwell, E. (Wisconsin)	Nonthermal emission from Theta Ori A. 3.5 and 2 cm.
AF-179	Fomalont, E. Hogan, C. (Steward Obs.) Partridge, B. (Haverford) Windhorst, R. (Arizona State)	CBR fluctuations. 3.8 cm.
AG-243	Giovannini, G. (Bologna) Feretti, L. (Bologna)	The extended source near Coma A. 90 cm.

No.	Observer(s)	Program
AG-275	Gottesman, S. (Florida) Hunter, J. (Florida) Mahon, M. (Florida)	The peculiar spindle galaxy NGC 2685. 20 cm line.
AG-294	Gregorini, L. (Bologna) Padrielli, L. (Bologna) Parma, P. (Bologna)	Radio galaxies of intermediate strength. 20 cm.
AG-295	Gregg, M. (Mt. Stromlo)	HI observations of the Bootes Void galaxies. 20 cm line.
AG-296	Gussie, G. (Calgary) Taylor, A. (Calgary)	HI in the young planetary nebulae NGC 7027 and IC418. 20 cm line.
AG-301	Giovanelli, R. (NAIC) Haynes, M. (Cornell)	Intergalactic HI cloud. 20 cm line.
AG-304	Geldzahler, B. (ARC)	X-ray triple 1916-05. 20 cm.
AG-309	Gwinn, C. (UCSB)	Reference source near W49N.
AG-310	Gabuzda, G. (JPL) Lestrade, J.-F. (JPL)	VLBI astrometry of stars. 3.8 cm.
AH-295	Habing, H. (Leiden) Goss, W. M. Winnberg, A. (Onsala) van Langevelde, H. (Leiden)	Monitoring OH/IR stars at the galactic center. 20 cm line.
AH-348	Hjellming, R. Han, X. (NMIMT) Cordova, F. (Penn State)	"Z-source" low mass X-ray binaries. 6 and 20 cm.
AH-353	Hurt, R. (UCLA) Turner, J. (UCLA)	Maffei 2. 2 and 6 cm line.
AH-377	Hawkins, G. (UCLA) Zuckerman, B. (UCLA)	HI around red giant W Hydrae. 20 cm line.
AH-380	Ho, P. (CFA) Yun, M. (CFA) Jackson, J. (MPIR, Bonn)	Hot cores in W51 and NGC 7538. 1.3 cm line.
AH-385	Han, X. (NMIMT) Hjellming, R.	Imaging the radio remnant of X-ray Nova V404 Cyg. 3.8 cm.

No.	Observer(s)	Program
AH-386	Hanisch, R. (STScI) Miley, G. (Leiden) Rottgering, H. (Leiden) de Jong, J. (Leiden)	Rich X-ray cluster Abell 2256. 20 cm.
AH-387	Hankins, T. (NMIMT) Cordes, J. (Cornell) Weisberg, J. (Carlton College)	Gated astrometry of pulsars.
AH-389	Hjellming, R. Han, X. (NMIMT) Johnston, K. (NRL)	Search for minutes-time-scale radio QPOs in strong X-ray binaries. 3.5 cm.
AH-390	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Toronto) Seaquist, E. (Toronto)	Resolving radio novae. 3.8, 6 and 20 cm.
AH-394	Howarth, I. (Univ. College London) Brown, A. (Colorado)	B supergiant winds. 3.8 and 6 cm.
AH-395	Howarth, I. (Univ. College London) Brown, A. (Colorado)	Emission from O stars. 3.8 cm.
AH-396	Huang, Z. (Beijing) Condon, J. Thuan, T. (Virginia) Yin, Q. (Beijing)	Compact starbursts and AGN. 3.8 cm.
AH-397	Hughes, V. (Queen's Univ.)	Variability of HII regions in Cepheus A. 2, 6 and 20 cm.
AH-398	Hughes, V. (Queen's Univ.) MacLeod, G. (Queen's Univ.) Moriarty-Schieven, G. (Queen's Univ.)	HII regions in dark clouds. 2, 6 and 20 cm.
AI-40	Inoue, M. (Nobeyama) Aizu, K. (Nobeyama) Tabara, H. (Utsunomiya) Kato, T. (Utsunomiya) Perley, R. Taylor, G. (UCLA)	Two candidate large rotation measure sources. 6 and 20 cm.
AJ-187	Johnston, K. (NRL) Webster, W. (GSFC) Seidelmann, P. (USNO) Altenhoff, W. (MPIR, Bonn)	The spatial distribution of the microwave emission from Ceres. 1.3 cm.

No.	Observer(s)	Program
AJ-188	Johnston, K. (NRL) Gaume, R. (NRL) Stolovy, S. (NRL) Wilson, T. (MPIR, Bonn) Wamsley, C. (MPIR, Bonn) Menten, K. (CFA)	Methanol masers associated with OMC-1. 1.3 cm line.
AJ-189	Johnston, K. (NRL) Claussen, M. (NRL) Bowers, P. (NRL)	Distance to IK Tau: Motions of water maser components. 1.3 cm line.
AK-225	Klein, U. (Bonn) Reuter, U. (MPIR, Bonn) Wielebinski, R. (MPIR, Bonn) Kronberg, P. (Toronto) Lesch, H. (Heidelberg)	Tracing the magnetic field in M82. 2 cm.
AK-234	Kundu, M. (Maryland) White, S. (Maryland) Schmahl, E. (Maryland) Gopalswamy, N. (Maryland)	Microwave and millimeter imaging of solar flares. 1.3 and 2 cm.
AK-235	Keens, J. (Caltech) Masson, C. (CFA) Menten, K. (CFA)	NH_3 emission in B335. 1.3 cm line.
AK-241	Kenny, H. (Calgary) Taylor, A. (Calgary)	AG Pegasi: Dynamics of the inner system. 2 and 6 cm.
AL-150	Lestrade, J.-F. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.
AL-213	Ladd, E. (CFA) Myers, P. (CFA) Wood, D. (CFA)	Ammonia in low and intermediate mass star formation regions. 1.3 cm line.
AL-215	Langston, G. Kassim, N. (NRL) Weiler, K. (NRL)	Filled-center supernova remnants. 1.3 and 3.8 cm.
AL-218	Lucas, R. (STScI) Chambers, K. (Johns Hopkins)	Texas survey sources. 20 cm.
AM-280	Menten, K. (CFA) Reid, M. (CFA) Johnston, K. (NRL) Walmsley, C. M. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	Emission from Methanol lines toward star forming regions. 1.3 cm line.

No.	Observer(s)	Program
AM-281	Menten, K. (CFA) Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn)	W28A2: neutral and ionized gas. 1.3 cm line.
AM-282	Menten, K. (CFA) Reid, M. (CFA) McClintock, J. (CFA) Leventhal, M. (Bell Labs)	Emission from the unique x-ray binary GX1+4. 3.5 cm.
AM-284	Muncy, L. (Maryland) Rudolph, A. (Maryland) Evans, N. (Texas) Zhou, S. (Texas)	Condensations in NGC 2024. 1.3 cm line.
AM-287	Martin-Pintado, J. (Yebes Obs.) Bachiller, R. (Yebes Obs.) Johnston, K. (NRL) Gaume, R. (NRL)	Ionized stellar winds: MWC349. 1.3 cm line.
AM-288	Masson, C. (CFA)	Measuring the angular expansion of W3(OH). 1.3 and 2 cm.
AM-293	Mirabel, I. (Puerto Rico) Rodriguez, L. (UNAM) Ruiz, A. (UNAM)	Continuum flux from the OH megamaser galaxies. 20 cm.
AM-294	Muhleman, D. (Caltech) Grossman, A. (Caltech) Slade, M. (JPL) Jurgens, R. (JPL) Butler, B. (Caltech)	Radar imaging of Venus. 3.8 cm.
AM-297	Murphy, D. (JPL) Perley, R.	Search for a counter jet in 3C 273. 20 cm.
AM-300	Menard, F. (IAP, Paris) Puche, D.	Sources in a selected sample of reflection nebulae. 3.5 cm.
AN-53	Niell, A. (Haystack) Lestrade, J.-F. (Paris Obs.) Lonsdale, C. (Haystack)	VLBI phase reference source near AE Aquarii. 3.6 and 20 cm.
AO-87	Owen, F. Eilek, J. (NMIMT) Cornwell, T.	Observations of M87. 90 cm.
AO-88	Owen, F. Eilek, J. (NMIMT)	Observations of M87. 3.8 cm.

No.	Observer(s)	Program
AO-94	O'Dea, C. (NFRA) Baum, S. (NFRA) Stanghellini, C. (Bologna)	What are the gigahertz-peaked spectrum sources? 1.3, 3.5, 6, 18 and 20 cm.
AP-170	Perley, R. Taylor, G. (UCLA) Inoue, M. (Nobeyama) Kato, T. (Utsunomiya) Tabara, H. (Utsunomiya)	Very large Faraday rotation in Hydra A. 3.8 cm.
AP-181	Pallavacini, R. (Arcetri) Kundu, M. (Maryland) White, S. (Maryland)	Post T-Tauri and naked T-Tauri stars. 6 cm.
AP-182	Patnaik, A. (NRAL) Browne, I. (NRAL) Wilkinson, P. (NRAL) Wrobel, J.	Calibrator sources for MERLIN. 3.5 cm.
AP-187	Perley, R. Roser, H. (MPIA, Heidelberg)	Pictor A. 1.3 and 2 cm.
AQ-04	Quirrenbach, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Schalinski, C. (MPIR, Bonn) Hummel, C. (MPIR, Bonn) Alberdi, A. (MPIR, Bonn) Johnston, K. (NRL) Zenus, A.	Rapid radio variability in 0917+624. 2, 3.6, 6, 20 and 90 cm. Four antenna subarray.
AR-203	Rodriguez, L. (UNAM) Anglada, G. (Barcelona) Estalella, R. (Barcelona) Torrelles, J. (IAA, Andalucia) Canto, J. (UNAM)	Low-luminosity sources of molecular and optical outflows. 3.8 cm.
AR-209	Reipurth, B. (ESO, Chile) Rodriguez, L. (UNAM)	HH 80-81 spectral indices. 3.8 and 6 cm.
AR-216	Reid, M. (CFA) Menten, K. (CFA)	Measurements of the size and temperature of Mira variables. 1.3, 2 and 3.8 cm.
AR-218	Rankin, J. (Vermont) McKinnon, M. (NMIMT) Hankins, T. (NMIMT)	Polarimetry of the pulsar PSR1702-19. 20 and 90 cm.

No.	Observer(s)	Program
AR-219	Rao, A. (Kapteyn Lab)	Candidate gravitational lens 1830-211. 1.3 and 2 cm.
AR-222	Roland, J. (IAP, France) Fraix-Burnet, D. (Toulouse Obs.) Mellier, Y. (Toulouse Obs.) Soucail, G. (Toulouse Obs.)	Study of an optical jet. 20 and 90 cm.
AS-333	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (Westerbork) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-349	Seaquist, E. (Toronto) Bell, M. (Herzberg)	Molecular absorption against Cen A. 1.3 and 2 cm line.
AS-368	Sadler, E. (Anglo-Australian Tele.) Whiteoak, J. (CSIRO)	HI velocity field in NGC 5077. 20 cm line.
AS-377	Szomoru, A. (Kapteyn Lab) van Gorkom, J. (Columbia) Sancisi, R. (Kapteyn Lab) van Woerden, H. (Kapteyn Lab)	Galaxies in the Bootes Void. 20 cm line.
AS-378	Seaquist, E. (Toronto) Taylor, A. (Calgary)	Survey of symbiotic stars at 8.4 GHz. 3.5 cm.
AS-384	Strom, R. (NFRA) van Paradijs, J. (Amsterdam) van der Klis, M. (Amsterdam)	Double radio sources associated with X-ray binaries. 1.3 and 2 cm.
AS-388	Seaquist, E. (Toronto) Smolinski, J. (Copernicus/Torun)	Supergiant binary HR8752. 1.3, 2, 3.8, 6 and 20 cm.
AS-392	Shaw, M. (Manchester) Wilkinson, A. (Manchester)	Radio properties of box/peanut galactic bulges. 20 cm.
AS-394	Sakurai, T. (Iowa) Spangler, S. (Iowa)	Extragalactic radio sources as a probe of the solar corona. 20 cm.
AS-396	Shastri, P. (Texas) Wills, B. (Texas)	Polarimetric test of the unified interpretation of quasars. 3.8, 6 and 20 cm.
AS-397	Skinner, S. (Colorado) Brown, A. (Colorado) Linsky, J. (Colorado)	Emission from massive pre-main sequence stars. 3.8 cm.

No.	Observer(s)	Program
AS-400	Sramek, R. Filippenko, A. (Berkeley) Sargent, W. (Caltech)	The Seyfert 1 nucleus of dwarf Sd galaxy NGC 4395. 3.8 cm.
AS-403	Strom, R. (NFRA) Penninx, W. (Amsterdam) van Paradijs, J. (Amsterdam) van der Klis, M. (Amsterdam)	Extended emission associated with Cyg X-1. 6 and 20 cm.
AT-105	Taylor, G. (UCLA) Perley, R.	Spectral index and depolarization of Hydra A. 20 and 90 cm.
AU-38	Ulmer, M. (Northwestern) Grabelsky, D. (Northwestern)	Pulsing X-ray source Her X-1. 20 cm.
AV-171	van Gorkom, J. (Columbia) Casertano, S. (Pittsburgh)	NGC 1683, a galaxy with a declining rotation curve. 20 cm line.
AV-177	Velusamy, T. (TIFR)	Pulsar candidates in SNR G33.6+0.1. 20 and 90 cm.
AW-230	Wrobel, J. Unger, S. (RGO)	Monitoring of the Seyfert NGC 5548. 3.5 cm.
AW-238	Wolter, A. (CFA) Gioia, I. (CFA) Maccacaro, T. (CFA) Stocke, J. (Colorado) Morris, S. (Mt. Wilson)	Study of radio properties of X-ray selected BL Lac objects. 2, 6, 20 and 90 cm.
AW-239	White, S. (Maryland) Kundu, M. (Maryland)	Flare stars at high frequencies and impulsive phase of optical flares. 2 cm.
AW-242	Willson, R. (Tufts) Lang, K. (Tufts)	Stellar bursts. 20 and 90 cm.
AW-243	Warner, P. (MRAO) Rees, N. (MRAO) Baldwin, J. (MRAO)	An object with a spectrum of 2. 3.8, 20 and 90 cm.
AW-244	Wootten, H. A. Mangum, J. Butner, H. (Texas)	Protostar in the Rho Oph complex. 1.3, 2 and 3.8 cm.

No.	Observer(s)	Program
AW-249	Wills, B. (Texas) Shastri, P. (Texas)	Core variability in lobe-dominated quasars. 6 cm.
AW-255	Worrall, D. (SAO) Murray, S. (SAO) Birkinshaw, M. (Harvard)	The Eridanus Einstein deep survey field. 6 cm.
AY-33	Yin, Q. (Beijing) Heeschen, D. Saslaw, W. (Virginia)	Study of nine likely starburst galaxies. 2, 6 and 20 cm.
AY-34	Yun, M. (Harvard) Ho, P. (CFA) Lo, K. (Illinois)	HI synthesis mapping of M82. 20 cm line.
AY-38	Yin, Q. (Beijing) Heeschen, D. Saslaw, W. (Virginia)	Study of position shift to the centers of 2259+157. 6 cm.
AZ-44	Zhao, J. (New Mexico) Ekers, R. (Australia Telescope) Goss, W. M. Lo, K. (Illinois) Narayan, R. (Steward Obs.)	Flux density variations caused by RISS in Sgr A. 3.8, 6 and 20 cm.
BV-01	van Langelvelde, H. (Leiden) Diamond, P. Habing, H. (Leiden) Winnberg, A. (Onsala) Goss, W. M.	Distance to the galactic center using OH/IR stars. 18 cm phased array MK III VLB.
BW-01	Wrobel, J.	PC-scale twist in the radio galaxy. 6 cm single dish.
V89-62	Felli, M. (Arectri)	HD 193793. 6 cm phased array MK III VLB.
VAH-49	Jauncey, D. (CSIRO) Jones, D. (JPL) Murphy, D. (JPL) Preston, R. (JPL) Meier, D. (JPL) Perley, R. Tzioumis, A. (Sydney)	Lens candidate 1830-211. 18 cm single antenna VLB.
VB-81	Barthel, N. (CFA) Rogers, A. (Haystack) Shapiro, I. (CFA)	The expansion and morphology of SN1979C. 6 cm phased array MK III VLB.

No.	Observer(s)	Program
VJ-54	Jones, D. (JPL) Dewey, R. (JPL) Gwinn, C. (UCSB) Linfield, R. (JPL) Davis, M. (Berkeley)	PSR 1937+214. 18 cm phased array MK III VLB.
VM-112	Mutel, R. (Iowa) Baum, S. (NFRA, Dwingeloo) O'Dea, C. (NFRA, Dwingeloo)	Maps of three compact doubles. 6 and 18 cm phased array VLB.
VP-100	Pauliny Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn)	High sensitivity optically selected quasars. 18 cm phased array MK III VLB.

E. SCIENTIFIC HIGHLIGHTS

Green Bank

K-Band Spectral Survey of IRC+10216 - Morley Bell (Herzberg) conducted a spectral survey of the circumstellar shell around IRC+10216. The survey turned up not only the previously discovered cyanodiacetylene, HC_5N, but two of its isotopes as well. These isotopes have never been seen before by any telescope, because of inadequate sensitivity. Each isotope substitutes a ^{13}C in place of a ^{12}C, but the isotopes differ in where the heavy carbon atom is situated.

In addition, HC_5N vibrational lines were discovered, ending a long quest that has been carried out on a variety of telescopes at many frequency bands.

Eclipsing Binary Pulsar - Joe Taylor (Princeton) and colleagues detected the eclipsing binary pulsar PSR1744-25 at 1.67 GHz using the 140-foot telescope. This is the highest frequency at which the pulsar has been detected. The pulsar is known to eclipse. The significance of timing at higher frequencies is that the plasma doing the eclipsing can be probed to a deeper depth than at lower frequencies. Indeed, the start and stop phases of the eclipse are slightly shifted in the 1.67 GHz case relative to that seen at lower frequencies.

Determination of all the orbital parameters is continuing at the 140 ft telescope, as Taylor plans to add measurements at 800 and 1330 MHz to his existing data base.

Socorro

Small Diameter Radio Sources in the Galactic Plane -- S. Zoonematkermani and D. Helfand (Columbia), R. Becker (UC/Davis and Livermore), R. White (STScI), and R. Perley have carried out an extensive survey of the galactic plane in the longitude range $-20° \leq \ell \leq 120°$ for latitudes $|b| \leq 0\overset{\circ}{.}8$ at 1400 MHz using the VLA in the B configuration. This is the first of several galactic plane surveys which are in progress using the VLA. The catalogue of 1991 sources detected in this survey is approximately 85 percent complete to a limiting peak flux density of 20 mJy for sources smaller than 20" in diameter. The dominant source populations of the survey are compact HII regions, young supernova remnants, planetary nebulae, and radio stars. The radio survey now provides a sensitivity that is well-matched to the IRAS all-sky survey in the far infrared and initial compilation of source coincidences between the VLA survey, IRAS and other radio surveys has been made. When coupled with the results of ongoing VLA plane surveys at 6 and 90 cm, the present 20 cm survey will provide a qualitatively new view of the radio source population of the Milky Way.

Tucson

Probes of Planetary Atmospheres. A recent novel use of the 12-meter has involved the study of molecular absorption lines in the atmospheres of Venus and Mars. Three transitions of CO, $J=1\rightarrow0$ (115 GHz), $2\rightarrow1$ (230 GHz), and $3\rightarrow2$ (345 GHz) have been used by two observing groups to study wind velocities, temperatures, and mixing profiles in the Venusian atmosphere, and the atmospheric temperature states of Mars.

Venus Wind Dynamics -- D. Buhl, G. Chin (GSFC), and J. Goldstein (Smithsonian Inst.) have investigated the wind dynamics and atmospheric circulation of the Venusian atmosphere by observing the CO absorption profile with the high resolution spectrometers at the 12 meter. They are able to measure wind velocities at the 20-30 m s^{-1} level, high (~100 km) in the atmosphere of Venus. The fundamental limitation on the accuracy of the measurement is the uncertainty in the laboratory rest frequency of CO. The group believes that ground-based millimeter wave observations of Venus may be one of the best probes of its atmosphere, both because of the high spectral resolutions available and the ability to probe to different depths of the atmosphere.

Probes of Venus and Mars -- R. T. Clancy (Colorado) and D. Muhleman (Caltech) have conducted a long-term study of Venus with the 12-meter, concentrating on atmospheric temperatures and mixing profiles. In addition, they have studied the temperature state of Mars up to a height of ~70 km. They find that in addition to the warm, dusty state observed by planetary spacecraft probes, a clear, cold state also exists. The atmospheric states may vary seasonally, or chaotically with the occurrence of storms.

F. 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.

G. CENTRAL DEVELOPMENT LABORATORY

Amplifier Development

Work has started on the 12-18 GHz amplifier prototype for the Green Bank, VLA, and VLBA receivers. The evaluation of HEMT's for a final version of the 40-45 GHz amplifier and possible 86 GHz amplifier continues.

Five of the new design 1.3-1.8 GHz amplifiers have been assembled, tested, and delivered. Noise performance at 12.5 K of all five is within 0.2 K from the prototype performance, that is, noise temperature of 2.8 K minimum and 3.1 K average. Improvement in both values is about 0.8 K upon cooling to the ambient temperature of 4.2 K.

The last 12 (of a total of 91) of the Voyager-style, 8.4 GHz amplifiers for the VLBA receivers, two 8-18 GHz amplifiers, and three 26-36 GHz amplifiers have been tested and delivered. Assembly work on another six of the 26-36 GHz amplifiers is near completion. Two room temperature 38 GHz amplifiers were tested and delivered for the purpose of a holography experiment on the 12 meter telescope.

Superconducting (SIS) Millimeter-Wave Mixer Development

Work continues on the construction of 25 SIS receiver inserts for the new closed-cycle cryostats being installed on the 12-meter telescope. These receivers will cover 68-90 GHz, 90-115 GHz, 130-170 GHz, and 200-260 GHz with two polarizations in each band, and an eight-beam, 230-GHz SIS receiver will replace the eight-beam Schottky receiver.

We now have acceptable SIS mixer designs for 68-90 GHz, 90-115 GHz, and 200-260 GHz. Work is starting on a 130-170 GHz mixer which we hope will be suitable for scaling to the higher frequency bands between 260 and 360 GHz.

Recent tests of $Nb/Al\text{-}Al_2O_3/Nb$ trilayer junctions made at the University of Virginia have given excellent results. In the 3-mm band we anticipate overall receiver noise temperatures equal to our present best ($19 \leq T_R \leq 30$ K DSB). In the 1.3-mm band the UVA mixers appear significantly better than others we have tested. We expect overall receiver noise temperatures of $70 \leq T_R \leq 150$ K DSB.

The supply of SIS junctions still limits our ability to design new mixers and improve the old ones. The recent success of the UVA niobium mixers and the flexibility of their fabrication process make them an ideal source for development of our new receivers. Unfortunately, the continued survival of the UVA group is in jeopardy because of lack of adequate grant support.

Collaboration on SIS device development also continues on a no-cost basis with IBM Watson Research Center and the University of Illinois/UC Berkeley.

During this quarter we have tested 26 SIS mixers operating from 68-260 GHz.

Schottky Diode Millimeter-Wave Mixers and Multipliers

In support of the 12-meter telescope and Millimeter Array site testing radiometers, we have built (or re-built) and tested a total of eight Schottky mixers and multipliers in the 230, 300, and 345 GHz bands during this quarter.

Acousto-Optical Spectrometer Project

During this quarter, testing of the system in the lab and refinement of the optics were pursued. Several changes to the optical path increased the optical efficiency by a factor of about 30 compared to the simplest configuration. These included changing the laser polarization, making fine adjustments to the Bragg angle, and adding a cylindrical lens ahead of the Bragg cell. The CCD can now be saturated with only 10 mW of CW into the Bragg cell, the usable bandwidth is 600 to 700 MHz, and the resolution is 2 MHz. Meanwhile, control of the scattered light has been improved by precisely adjustable slit baffles before the Bragg cell and before the CCD array.

With these improvements, the scattered light level is about 30 dB below the signal. This is far from good enough, because fluctuations in the scattered light reaching the CCD limit the dynamic range. When observing broadband noise, the rms fluctuations after long integrations can be kept at the theoretical value, but only by switching between signal and reference at a rate of several hertz. Slower switching results in higher fluctuations due to the scattered light. Various tests to isolate the cause of the remaining scattered light have been done. It appears that we are presently limited by the Bragg cell itself. Imperfections in the crystal are thought to be the dominant problem. Lower level, but still important, scattering sources could be imperfections in the camera lens and the window on the CCD chip.

Short of replacing the Bragg cell, further improvements might be made by (1) removing the CCD window, (2) modifying the mechanical design to increase rigidity, and (3) putting the optical path in thermally-stable enclosure. At the end of the quarter, work was proceeding in these areas. In addition, engineering work needed to make the system usable at the telescope is going ahead to the extent that it is independent of the type of Bragg cell. This includes design of an IEEE-488 interface to the host computer.

It is likely that a spectrometer for telescope use will require a Bragg cell using $LiNbO_3$ (vs. GaP) in a polarization-switching mode. Such devices are available in bandwidths of 500 to 1000 MHz at a cost of $10-14k. The present year's budget of $5k will allow completion of the other parts of the prototype.

H. GREEN BANK ELECTRONICS

A major project is underway to replace the collapsed 300-ft telescope with a state-of-the-art 100-meter class telescope. The Green Bank electronics division is supplying expertise to the design effort in a few areas. The design of the optics for the telescope is being refined. Surface shape, subreflector shape and positioning, and receiver positioning have been detailed. Components for the active surface, in particular, Linear Variable Differential Transformers (position transducers) and DC gearmotors, are currently being tested. The details of a scheme to provide highly accurate pointing, using collimators, mirrors and shielded light beams, are being worked out.

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. A 610 MHz receiver has also 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.

Progress was made on several fronts during the past quarter. Firstly, a 500 MHz to 5 MHz converter to improve phase calibration of the VLBI data was added to the receiver on 85-3. Preliminary analysis of the data indicate this significantly improved the quality of the data. However, it appears that there is still more noise than expected in the data. Secondly, the feed and back end for a 327 MHz receiver for the 85-3 antenna were tested. Installation on the telescope is imminent. Finally, test procedures for the data acquisition terminal baseband converters have been refined. As a result, six converters were completed during the quarter. Fifteen more are in various states of assembly and test.

140-foot Cassegrain Receivers

The current 140-foot cassegrain receiver system uses 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 continued. It is estimated that the upgrade to 32 GHz is 80 percent complete, with completion of this part of the project slated for late 1990. The level of effort on this project has been scaled down significantly due to manpower limitations.

Spectral Processor

The Spectral Processor is a high time resolution spectrometer capable of producing two 40 MHz spectra each 25.6 μs. A fair amount of flexibility, in terms of bandwidth, number of channels, and averaging time, is included to make the instrument useful for spectroscopy. It has special signal averaging capabilities built-in to facilitate its use as a pulsar back-end.

A subsystem consisting of two IF to video converters and half of the digital electronics has been in operation for several months. Modules for the remaining seven IF to baseband converters are all tested. Only the chassis wiring remains. Digital cards for the second half of the system and for spares are all assembled and about 90 percent are tested.

Miscellaneous

Construction of the L-band VLBA receivers was completed during this quarter. One S-band VLBA receiver was also completed, with a second well underway. Construction of the 2-16 GHz VLBA local oscillators continues. The full complement of 38 should be complete by June.

I. 12-METER ELECTRONICS

New 1.3 mm SIS Receiver

A new 1.3 mm, dual-polarization SIS receiver will be available for use by observers in the fall observing period this year. A prototype version of this receiver is now completed and has been successfully tested on the telescope. The receiver will be available for general use by November.

The receiver will tune between at least 200 - 240 GHz and will have a receiver noise temperature, including all receiver optics, of ≤ 400 K (SSB) over this frequency range. Recent developments in the Central Development Laboratory (above) suggest that by the fall the receiver may have both a larger tuning range and a considerably lower noise temperature.

This is the first of the new-generation SIS receivers to go on the 12-meter. The two SIS mixers are housed in an 8-port cryostat, that is intended to contain up to four dual-polarization pairs of receivers, each covering a different waveband. Two such 8-port cryostats will be constructed, containing receivers that will eventually cover all the atmospheric windows available at the 12-meter. Each lens, feedhorn, and mixer assembly is housed in a removable insert. The cryostats are closed-cycle, 4 K systems that should be more efficient than the hybrid (liquid helium) cryostat in use on the current 3 mm SIS receiver at the 12-meter. In addition, this will be the first computer-tuned receiver on the 12-meter. The use of computer tuning eliminates the need for separate control racks for each receiver, which speeds up the construction time scale and reduces the shortage of rack space in the control room.

This is a joint project between Tucson Operations and the Central Development Laboratory.

Eight Beam Receiver News

The Eight Beam Receiver, which is the first step toward a millimeter-wave imaging camera, has seen considerable use in the first quarter of 1990. The receiver experienced some initial reliability problems, but is now performing well. The quality of spectral baselines has been improved also. In addition, a number of software enhancements have been made, including an on-line pen plotter that records spectral data for each of the eight beams, each time a scan is completed.

J. 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 causes a 30 percent change in amplitude. Solar-induced tilts, which used to dominate our pointing errors, have been greatly reduced through external insulation of the antenna yoke and base support.

An important pointing problem being investigated now is the occurrence of tilts of up to 20 arcseconds in the azimuth axis of a few antennas at certain azimuth angles. This effect is believed to be caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Testing of the stability of the redesigned tilt-meter units show a long-term stability of about 3 arcseconds. Eight units have been fabricated and tested. Two VLA antennas have been outfitted with two sets of tilt-meters on each antenna. Engineering testing of these four units installed on the antenna are complete. Further system testing will continue through 1990.

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 low frequencies is required to better understand the type of algorithm needed. To do this, we are equipping the current 25-meter antennas with simple dipole-type feeds. Note that if every 25-meter antenna had such a feed the entire 3C and 4C catalog could be mapped at 75 MHz with the same resolution as the original 1400 MHz aperture synthesis catalog done at Cambridge. The cost of this outfitting is very modest.

The crossed dipole was chosen as the easiest feed to implement on the VLA antennas. Testing of this feed showed it had no effect on other frequencies. The measured efficiency of this system is 20 percent. With the new feed installed near the focus of the antenna, locally generated radio frequency interference became a significant problem (see RFI Improvements). Eight antennas are equipped with the 75 MHz system. No more outfitting is planned in 1990 pending further astronomical testing.

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, so enclosing the radiating components with RFI shields is necessary.

Four prototype RFI enclosures for the vertex mounted "B" racks have been installed and tested. 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 almost complete. Material for a prototype unit has been ordered.

1.3-1.7 GHz T_{sys} Improvements

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

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

For example, using cryogenically cooled HEMT amplifiers on the fully optimized VLBA antennas, the measured system noise temperature is 30 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, a VLBA front-end installed on a VLA antenna gave a system temperature of about 35 K.

A project to install VLBA style 18-21 cm front-ends on all of the VLA antennas is now underway. The material to assemble two of the new front-end systems is now in hand and material for three more systems is on order.

High Time Resolution Processor

We are currently instrumenting the VLA with a high time resolution processor (HTRP). The system will be used for observations of time varying phenomena like flare stars, pulsars etc., and for monitoring radio frequency interference (RFI). The system utilizes existing components such as the VLA analog sum phased array outputs and the VLBI MK III IF-Video converter system which serves as a set of tunable filters with selectable bandwidths. This provides 14 pairs of RCP and LCP frequency signals from the phased array VLA. Total power detectors and cross multipliers are used to measure all four products with integration periods of 25 microsececonds to 5 milliseconds. The data acquisition system is a 64-channel multiplexer and a 12-bit analog to digital converter with maximum sampling rate of 100,000 samples/sec. This is installed on a 386-based personal computer with a 20 MHz clock and a 140 MB hard disk. The data acquisition system has been used to obtain 2-channel phased array VLA signals for developing software and understanding the system stability problems. The fabrication of the 64-channel system is complete and bench testing is well underway.

K. AIPS

The general distribution of the 15JAN90 release of AIPS was cancelled. There were two main reasons for this. The installation of the first release of the overhauled code (15OCT89) had not gone as smoothly as hoped at remote computer sites, and major enhancements to the VLA specific data filling and calibration were not available at the time of the code freeze for this release. The release was made available to any site that these problems did not affect, i.e., sites with existing AIPS installations processing VLBI data or already calibrated VLA data.

However, it was recognized that it was imperative that the next release (15APR90) be very stable and well debugged. Accordingly, the code was frozen one month before the release date. This enabled the programmers to verify the installation procedures for remote sites and to run the verification suite (DDT) on the release. Since the early freeze turned up several potentially serious problems, it has been decided that the AIPS group will freeze development on all future releases one calendar month ahead of the release date.

During the quarter, a successful installation of AIPS on a Cray Y-MP running UNICOS was achieved. This is now installed at Cray headquarters and on a Cray X-MP at the universities of Minnesota and Toronto. The system uses the virtual TV facility, using the display facilities provided by a SUN workstation.

There is a new edition of AIPS programmers' guide (Going AIPS). This has been updated to include many of the changes incorporated during the code overhaul to Fortran 77. Work is in progress to update the user documentation. The new edition of the AIPS cookbook should be available by the summer. Work is also in progress on an AIPS manager's handbook.

L. VLA COMPUTER

The online ModComp system now supports additional correlator modes. With the software update of February 28, 1990, the VLA online system has been enhanced to make available most of the spectral line modes that are supported by the correlator. All single IF modes (1A, 1B, 1C, and 1D) should function as before. The change should be transparent in these modes. All 2 IF modes (2AB, 2AC, 2AD, 2BC, 2BD, and 2CD) now function correctly. Until now, modes 2BC and 2BD were not supported. The 4 IF mode (4) produces data. This allows one spectrum per IF for all baselines. The polarization modes (PA and PB) produce data. These produce four spectra per baseline. The spectra are AA, CC, AC, and CA for mode PA, and BB, DD, BD, and DB for PB. Multiple subarrays in spectral line mode are supported, but mixed spectral line and continuum subarrays are not allowed. Autocorrelation spectra are produced for all active antennas. The autocorrelation spectra are handled in the same way as the cross-correlation data (i.e., the options for lag spectra, Hanning smoothing, and data selection are applied). Work continues in both AIPS and ISIS to accommodate the new correlator data. This is the first time that many modes designed into the VLA correlator are available for testing.

The DICOMED film recorder is now fully operational. Software support from AIPS as well as for SunView screen dumps is available. The AIPS tasks TVFLM spools the IIS tv display to the dicomed while the task IMFLM spools image data to the dicomed using the current IIS transfer function and color tables. The ISIS task DICREC spools a SunView rasterfile. User requests are handled automatically. Computer operations exposes the film and returns the color slide or print to the user.

The PC version of OBSERVE is currently undergoing testing and should be available second quarter this year. The OBSERVE program supports the full set of correlator modes now available from the ModComp online system.

M. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The Fort Davis, TX site was declared the fourth operable antenna in the first quarter of 1990. Test and evaluation observing, remotely controlled from Socorro, are underway. Staffing adequate to support Network observing at this site, however, is not expected until early 1991. The Pie Town, Los Alamos, and Kitt Peak antennas participated in 6 and 18 cm Network observations in March, and Pie Town additionally at 2.8 cm. Pie Town also participated in NASA/JPL network crustal dynamics runs in January, February, and March.

Mechanical and electronic outfitting is underway at the North Liberty, IA antenna. Erection of the Brewster, WA antenna is about 80 percent complete. Outfitting is scheduled to start this summer. The Owens Valley, CA antenna is complete. It awaits outfitting scheduled for this winter. The Hancock, NH site work is almost complete. Antenna erection there is scheduled to start this spring. A favorable result from a Saint Croix government hearing has apparently cleared the way for site construction to resume soon. Approximately two months of uninterrupted work at this site should complete the antenna foundation. A bid package for site construction at the Mauna Kea, HI location is expected to be issued by NRAO in April.

Electronics

In the area of front-ends, the first of the new design units for 2.3 GHz with the higher capacity (CTI model 350) refrigerators was completed and tested. It is now awaiting installation at Pie Town. Both 8.4 GHz and 23 GHz front ends through serial No. 6 have been completed and shipped to Socorro. Fabrication drawings for the prototype 43 GHz front end have been completed. The unit is under construction and should be ready for testing by the end of June. Work on the last four 4.8 GHz front ends has been started. These units will be completed by the end of the year. Racks of type A, B, and C for North Liberty have been checked out and are awaiting shipment to the site for outfitting in April. The D rack (Data Acquisition) for North Liberty has been completed, but during final checkout a problem was found in the formatter. It is expected that this rack will be shipped about a week later than the other three racks.

During this quarter much progress has been made on final checkout and adjustment of Baseband Converter modules that had been constructed at NRAO during the past year. A number of critical capacitors were replaced with higher tolerance units, details of the adjustment procedure used for the earlier modules of this type made at Haystack Observatory were obtained, and a computer controlled testing routine was developed. It is expected that we should have caught up with Baseband Converter production by about mid-year. The construction plan calls for completion of all of the A, B, and C-type racks by the end of the year. The main items then remaining will be front ends and converter modules for several frequency bands, spare modules, and the second D-rack for each antenna.

Data Recording

Haystack Observatory has now completed a total of twelve data recording systems, plus one kit to be assembled at the AOC to train VLBA maintenance personnel. The last eight units are being equipped from the first batch of commercially (Honeywell) produced MkIIIA/VLBA narrow track headstacks. Electronics for simultaneous 36 track playback/bit synchronization to the VLBA correlator have now been developed by Haystack. A first set has been delivered to the Charlottesville correlator laboratory to facilitate its interface development and test. Haystack Observatory has recently demonstrated recording at a rate over 1 Gigabit per second on a VLBA recorder specially equipped with an additional three simultaneously driven headstacks.

Monitor and Control

During first quarter 1990 the primary concern has been with the conversion of the array control software to run under the VxWorks operating system. We have produced a disk resident version of the operating system, which appears to have some remaining problems with the network software if ethernet is not included. The software that was running under VersaDos has been converted to VxWorks, with minor exceptions: the software dealing with the VLBA tape transport and formatter, and the stand-alone programs (e.g., tiltmeter data collection, antenna servo performance, holography scanning). However, many of these existing programs have received only minimal debugging, so the system is not yet operable, much less robust.

The VxWorks operating system imposes much more severe requirements on the communications system, so we have had to devote time to understanding the performance of the various devices in the remarkably complex communication link.

The CPU board in the station computer, a MVME 121, is an obsolescent device, slow, without hardware floating point, and with a single terminal line. Since we need more terminal lines at the stations than we have, and since it appears to be relatively inexpensive to replace the CPU board with a more modern version with four terminal lines, we propose to do so. The more modern device, the MVME 147, comes in several models, differing by a factor of 1.5 in speed, 2 in amount of memory, and 1.9 in price between the most and least expensive version. The decision about which version is to be installed at all the stations remains to be made. However, we will shortly begin work on the system software for the new board, which is expected to be a fairly straightforward task.

Pie Town is currently using this operating system for an intensive debugging phase. The goal is to use the system for the first time for real observing on April 11, for MkIII emulation observing on April 21, and for a crustal dynamics project observing run on April 26.

Correlator

Analysis of the third prototype version of the correlator "F chip," delivered late in the previous quarter, confirmed initial indications that it too failed the manufacturing tests developed by NRAO engineers as part of the overall design process. Two of the several alternative approaches under study for some months were selected for final consideration. While this work was in process, the manufacturer determined that failures in a number of other customers' applications could also be attributed to marginal performance of the on-chip memory in the basic "structured array" product. A new structured array, identical except for replacement of the memory by a state-of-the-art, machine-compiled configuration, was devised as a general solution to these failures. This was essentially the outcome anticipated at the end of the previous quarter. The distinction between the new product and a "custom structured array" is fundamentally a matter of marketing terminology.

These decisions were reviewed, and a schedule for yet another prototype outlined, at a meeting on February 9 at LSI Logic in Bethesda, MD. NRAO's design became the first application implemented in the new structured array, and a full complement of 40 prototype chips was received on March 16--a month earlier than was promised in February, but nearly 13 months later than specified in NRAO's purchase order. With this fourth prototype version finally passing manufacturing tests (i.e., performing as predicted by the vendor-guaranteed simulations), payment of the final 20 percent installment of engineering charges was authorized. An extensive evaluation, verifying conformance to the designed functionality, will continue through much of the following quarter. Initial test results to date have been entirely satisfactory.

The purchase order for both design and fabrication of these chips had been issued to Hall-Mark Electronics, based on a bid submitted jointly by Hall-Mark and LSI Logic. These two firms terminated their distributorship agreement during this quarter. Both have continued to support the design effort, culminating in the successful prototype chips described above, but it is not clear at present who will manage the production phase.

Prototypes of the parallel read and bit-synchronizer modules were received on March 29, completing the first correlator Playback Drive (which had been received in an acquisition configuration 10 months earlier). At the same time, Data Acquisition Rack 6 was returned from Haystack, where it had been used in checking out these modules. Both units are now available for final checkout of the prototype playback interface boards.

As anticipated in designing the high-level control software around a commercial database management system, it has facilitated rapid progress in developing applications for this area. Substantially complete modules are already in place for entry and validation of observing logs, automatic recognition of sub-arrays, and writing the control script. These advances have been sufficient that further work in this area could be suspended in order to concentrate the software team's efforts on the real-time system.

Data Processing

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

Software development this quarter consisted of further development of editing and spectroscopic calibration functions and the debugging and making minor improvements to the calibration software. Development of spectroscopic calibration software is nearly complete. In particular, progress has been made in the processing of MkIII VLBI data for both continuum and spectroscopic data. MkIII data is very similar to VLBA format data.

N. PERSONNEL

New Hires

Frail, D.	Research Associate	01/01/90
Price, R. M.	Visiting Scientist	01/17/90
Usowicz, J.	Visiting Scientist	01/19/90
Sahr, W.	Sr. Sci. Programming Analyst	03/12/90

Terminations

van Gorkom, J.	Scientist	01/22/90
Biemesderfer, C.	Scientific Programmer	02/20/90

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