

NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

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PROPERTY OF THE U. S. GOVERNMENT
RADIO ASTRONOMY OBSERVATORY
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A. TELESCOPE USAGE

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

	<u>140 Foot</u>	<u>12 Meter</u>	<u>VLA</u>
Scheduled observing (hours)	1873.25	301.5	1728.6
Scheduled maintenance and equipment changes	170.00	1906.5	252.1
Scheduled tests and calibration	109.75	-	233.4
Time lost	68.75	50.5	140.0
Actual observing	1804.50	251.0	1588.6

B. 140 FOOT TELESCOPE

The following line programs were conducted during this quarter.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
A108	Albert, E. (USNA) Danly, L. (STScI) Roberts, B. (USNA)	Observations of HI to map clouds in the galactic halo.
B533	Bell, M. (NRC, Herzberg) Seaquist, E. (Toronto)	Observations of CH and H ₂ CH at 9 cm to examine the dust lane and nuclear region of Cent A.
B551	Brown, R. Vanden Bout, P.	Observations of redshifted CO in IRAS 10214+4724.
C269	Clegg, A. (NRL)	Observations at 18 cm to study the short time scale variability of interstellar OH masers.
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.
G323	Giovanelli, R. (Cornell) Haynes, M. (Cornell) Gina, J. (Reed College)	Observations of intergalactic HI.
H278	Heiles, C. (Berkley) Goodman, A. (Berkeley) Troland, T. (Kentucky) Crutcher, R. (Illinois)	Observations of 18 cm OH lines in absorption against W22, Cas A, and other sources to determine the existence of linear polarization.
L244	Lockman, F. J.	Search at 4.874 GHz for low surface brightness HII regions.
L254	Lockman, F. J. Savage, B. (Wisconsin)	Search at 1420 MHz for HI worms.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
L262	Lockman, F. J. Reynolds, R. (Wisconsin)	Observations of HI toward selected globular clusters.
M309	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.
M322	Magnani, L. (Georgia) Onello, J. (SUNY, Cortland)	Observations of CH at 3.335 GHz at the edge of MBM16.
P157	Payne, H. (STScI) Anantharamaiah, K. (Raman Institute) Erickson, W. (Maryland)	Observations at 500-1000 MHz of Carbon recombination lines toward Cas A.
P158	Petuchowski, S. (NASA/GSFC) Kogut, A. (NASA/GSFC) Bennett, C. (NASA/GSFC)	Search at 4.83 GHz for formaldehyde absorption in ten nearby galaxies to provide a base sample for multi-transitional studies.
T248	Turner, B.	Search for hyperfine CH lines at 702, 704, 722, and 724 MHz.
T270	Turner, B. Lubowich, D. (Hofstra/AIP) Hobbs, L. (Chicago)	Search for the 732.1533 MHz hyperfine transition of B(11) in the galactic center.
V76	Verschuur, G. (unaffiliated)	Zeeman effect mapping at 1420 MHz of fields in 21 cm emission structures.
Y10	Yanny, B. (Princeton) Carilli, C. Rupen, M. (CFA) York, D. (Chicago) Brown, R.	Search over the range of 800-1000 MHz for redshifted HI.

The following pulsar programs were conducted during this quarter.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
B484	Backer, D. (Berkeley) Foster, R. (NRL)	Timing observations over the range of 800-840 MHz and at 1330 MHz of PSR1821-24 and other millisecond pulsars.
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.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
T265	Taylor, J. (Princeton) Stinebring, D. (Oberlin) Nice, D. (Princeton) Thorsett, S. (Caltech) Arzoumanian, Z. (Princeton) Pande, V. (Princeton)	Pulsar timing observations over the range 800-840, and 1330 MHz.
T302	Taylor, J. (Princeton) Nice, D. (Princeton) Thorsett, S. (Caltech) Arzoumanian, Z. (Princeton) Shrauner, J. (Princeton) Wan, L. (Princeton)	Pulsar timing observations over the range 1300-1350 MHz.

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

A - Arecibo 300 m	No - Sicily 32 m
B - Effelsburg, MPIR 100 m	O - Owens Valley 130 ft
G - Green Bank 140 ft	Pt - Pietown 25 m
Jb - Jodrell Bank 250 ft	Sn - Onsala 20 m
Jn - Merlin Array	T - Torun 15 m
Km - Haystack 120 ft	VLBA - All available VLBA 25 m
Kp - Kitt Peak 25 m	Wn - Westerbork n = 1-14x26 m
Lb - Bologna 25 m	Yn - Socorro n = 1-27x25 m
Lm - Medicina 32 m	

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
GA4	Benz, A. (SFIT, ETH) Guendel, M. (SFIT, ETH) Alef, W. (MPIR, Bonn)	Observations at 6 and 18 cm of dMe-Stars with telescopes A, B, G, Jb, and Y ₂₇ .
GB11	van der Hucht, K. (Utrecht) de Bruyn, A. (NFRA) Verheijen, M. (Leiden) Williams, P. (Royal Obs.) Spoelstra, T. (NFRA)	Observations at 6 and 18 cm to monitor the WR binary HD193793, with telescopes B, W ₁₄ , Jb, No, Sn, G, Km, and Y ₂₇ .
GB9	Barthel, P. (Groningen/Kapteyn) De Bruyn, A. (NFRA) Schilizzi, R. (NFRA) O'Dea, C. (STScI) Wieringa, M. (Leiden) Bogers, W. (Groningen/Kapteyn)	Observations at 6 cm to map the core radio morphology of galaxy 1245+67, with telescopes B, W ₁₄ , Lm, Jb, Sn, Y ₂₇ , O, and G.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
GC2	Cohen, M. (Caltech) Conway, J. (Caltech) Unwin, S. Caltech) Zensus, A. Wehrle, A. (JPL) Goodrich, R. (Caltech)	Global VLBI/Merlin observations of 3C 345 at 6 cm, with telescopes Sn, B, Wn, Lm, Lb, Km, G, Y ₁ , VLBA, and Merlin Jn.
GD1	Dallacasa, D. (Bologna) Stranghellini, C. (Bologna) Fanti, C. (Bologna) Fanti, R. (Bologna) Schilizzi, R. (NFRA) Spencer, R. (Manchester) O'Dea, C. (STScI) Baum, S. (Johns Hopkins)	Observations at 6 cm of ten small CSS radio sources, with telescopes Sn, B, Wn, Jb, Lb, No, G, Km, O, Y ₂₇ , PT, and KP.
GJ2	Jones, D. (JPL) Murphy, D. (JPL) Preston, R. (JPL) Meier, D. (JPL) Jauncey, D. (Australia Telescope) Tzioumis, A. (Australia Telescope) Reynolds, J. (Australia Telescope) Perley, R. Patnaik, A. (Manchester) Muxlow, T. (Manchester) Rao, A. (TIFR)	Second epoch 6 cm observations of 1830-211, with telescopes Sn, B, Wn, Jb, Lm, No, Km, G, Y ₁ , O, and VLBA.
GL2	Lestrade, J.-F. (Meudon) Phillips, R. (Haystack)	Observations at 6 cm of the magnetic structure of the close stellar binary UX Arietis, with telescopes B, Wn, Lm, G, Km, Y ₂₇ , O, and A.
GL3	Lara, L. (IAA, Granada) Muxlow, T. (Manchester) Alberdi, A. (IAA, Granada) Marcaide, J. (IAA, Granada) Junor, W. Saikia, D. (TIFR)	6 cm observations of the peculiar quasar 3C 395, with telescopes B, Lm, Sn, No, Km, Wn, G, Jb, O, and VLBA.
GL4	Lestrade, J.-F. (Meudon) Phillips, R. (Haystack) Gabuzda, D. (Calgary) Preston, R. (JPL)	Phase-referenced VLBI observations at 6 cm of RS CVn stars for HIPPARCOS, with telescopes Lm, B, Km, G, Y ₂₇ , and O.
GL5	Lonsdale, C. (Haystack) Lonsdale, C. (IPAC, Pasadena) Smith, H. (Calif., San Diego)	An 18 cm survey of starburst galaxies, with telescopes B, Jb, W ₁₄ , G, Y ₂₇ , and A.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
GM10	Marcaide, J. (IAA, Granada) Elosequi, P. (IAA, Granada) Shapiro, I. (CFA)	Study at 6 cm of the core of the quasar 1038+528, with telescopes B, Lm, T, No, Km, G, Y ₂₇ , and VLBA.
GP3	Phillips, R. (Haystack) Lonsdale, C. (Haystack) Feigelson, E. (Penn State)	Observations at 6 and 18 cm of a bright, nonthermal T-Tauri star, with telescopes B, Jb, W ₁₄ , G, O, A, and Y ₂₇ .
GP7	Wilkinson, P. (Manchester) Readhead, A. (Caltech) Polatidis, A. (Manchester) Xu, W. (Caltech) Pearson, T. (Caltech)	A large scale VLBI snapshot survey at 18 cm (Part 3), with telescopes B, Lb, Sn, Wn, Jb, R, G, Km, O, Y ₁ , and VLBA.
GS1	Schilizzi, R. (NFRA) Fanti, C. (Bologna) Fanti, R. (Bologna) Spencer, R. (Manchester) Sanghera, H. (Manchester) Venturi, T. (Bologna) Ren-Dong, N. (Beijing Obs.) van Breugel, W. (Caltech)	Observations at 6 cm to determine the location of the core in 3C 343, with telescopes Jb, Wn, B, Sn, Lm, G, No, Km, Y ₂₇ , O, and PT.
GX2	Xu, W. (Caltech) Readhead, A. (Caltech) Wilkinson, P. (Manchester) Polatidis, A. (Manchester) Pearson, T. (Caltech) Lawrence, C. (Caltech) Herbig, T. (Caltech)	A large scale VLBI snapshot survey at 6 cm (Part 2), with telescopes Lb, Sn, Wn, G, Km, O, Y ₂₇ , and VLBA.
M331	Matsakis, D. (USNO) McCarthy, D. (USNO)	Observations at 1.6 GHz of OH masers.
UAH5	Hewitt, J. (Haystack)	Fringe test observations at 18 cm for phase reference sources.
UB2	Bartel, N. (CFA) Chandler, J. (CFA) Ratner, M. (CFA) Shapiro, I. (CFA)	Gravitational redshift test at 18 cm via millisecond pulsar VLBI, with telescopes B, G, A, Km, and Y ₂₇ .
UF1	Feigelson, E. (Penn State) Phillips, R. (Haystack) Lonsdale, C. (Haystack)	Test observations at 18 cm of classical T-Tauri stars, with telescopes B, G, Y ₂₇ , and A.

C. 12 METER TELESCOPE

The following line programs were conducted during this quarter.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
B553	Brown, R. Vanden Bout, P.	Search for CO from HI z galaxy.
B556	Brown, R.	Study of CO in the HI absorption cloud toward 3C 196.
L249	Loren, R. (unaffiliated) Wootten, H. A.	Study of temperature determinations in ultra opaque cores in rho Oph cloud.
L250	Loren, R. (unaffiliated) Wootten, H. A.	Study of molecular abundances in oxygen-rich cores in the rho Oph cloud.
P156	Pound, M. (Maryland) Blitz, L. (Maryland)	A search for proto-brown dwarfs.
T289	Turner, B.	A search for PO in cold dense molecular clouds.
W297	Wilk, K. (Waterloo) Fich, M. (Waterloo)	Study of star formation conditions around small nearby HII regions.

D. VERY LARGE ARRAY

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AA123	Andre, P. Feigelson, E. (Penn State) Leous, J. (Penn State) Montmerle, T. (CNRS, France)	Circular polarization from magnetic star S1 in rho Oph cloud. 3.8 cm.
AA127	Alexander, P. (Cambridge) Crane, P. Wilding, T. (Cambridge) Pooley, G. (Cambridge)	Star-formation rate in galaxies. 90 cm.
AA128	Alexander, P. (Cambridge) Mackay, C. (Cambridge) Leahy, J. (Manchester) Pooley, G. (Cambridge)	Structure of the inner jet of 3C 66B. 2, 3.8, 20 cm.
AA129	Akujor, C. (Nigeria)	Depolarization in compact steep-spectrum sources. 6, 20 cm.
AA130	Anantharamaiah, K. (Raman Institute) Cornwell, T.	X-shaped structures in 1437-153. 6, 20, 90 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AB414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2, 6 cm.
AB456	Burke, B. (MIT) Hewitt, J. (Haystack Obs) Roberts, D. (Brandeis)	0957+561 A, B. 6 cm.
AB587	Burns, J. (New Mexico State) Clarke, D. (Illinois)	The inner lobes and jet of Centaurus A. 3.8 cm.
AB597	Bookbinder, J. (CFA) Pye, J. (Leicester) Bromage, G. (RAL) Saar, S. (CFA)	Stellar flares on UV Ceti and AT Mic: multiband observations. 2, 3.8, 6, 20 cm line.
AB604	Bastian, T. Zirker, J. (NOAO-NSO)	Spatial power spectrum of the sun. 1.3, 2, 3.8, 6, 20 cm.
AB605	Baum, S. (Johns Hopkins) O'Dea, C. (STScI) Pedlar, A. (Manchester)	HI absorption as a probe of the obscuring Torus in Seyfert galaxies. 20 cm line.
AB607	Benz, A. (SFIT, ETH) Guedel, M. (Colorado/JILA) Schmitt, M. (MPIfEP, Garching)	Monitoring the quiescent radio emission of UV Cet. 2, 3.8, 6 cm.
AB608	Biretta, J. Perley, R.	Search for superluminal motion in kiloparsec scale jets: 3C 273, 3C 279. 2, 6 cm line.
AB609	Bridle, A. Clarke, D. (Illinois) Perley, R. Burns, J. (New Mexico State)	Internal structure of jets in 3C 219. 2, 3.8 cm.
AB610	Burke, B. (MIT) Ekers, R. (Australia Telescope) Wright, A. (Australia Telescope) Fletcher, A. (MIT) Griffith, M. (MIT)	Southern hemisphere extension to the VLA gravitational lens search. 3.8 cm.
AB611	Burke, B. (MIT) Turner, E. (Princeton) Fletcher, A. (MIT) Lehar, J. (MIT) Herold, L. (MIT) Conner, S. (MIT)	MG-VLA gravitational lens search. 3.8 cm.
AB612	Biretta, J. Owen, F.	Monitoring of proper motions in the M87 jet. 2 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AB616	Becker, R. (Calif., Davis) White, R. (STScI) Deustua, S. (IGPP/LLNL)	Candidate GPS. 3.8, 6, 20, 90 cm.
AC278	Carilli, C. Ho, P. (CFA)	Nuclear starburst galaxy NGC 253. 90 cm.
AC299	Catarzi, M. (Arcetri) Cesaroni, R. (MPIR, Bonn)	Water maser and disk structure in star forming regions. 1.3 cm line.
AC300	Clegg, A. (NRL)	Interstellar OH masers: S269 and ON1. 20 cm line.
AC301	Condon, J. Wrobel, J.	UGC galaxies at high resolution. 20 cm.
AC302	Conway, J. (Caltech) Vermeulen, R. (Caltech) Hough, D. (Trinity) Readhead, A. (Caltech)	Positions for VLBI phase-referencing near lobe-dominated sources. 3.8 cm.
AD266	Dougherty, S. (Calgary) Taylor, A. (Calgary)	Imaging the circumstellar envelope of the Be star Psi Persei. 2 cm.
AD268	de Pater, I. (Berkeley) Mitchell, D. (Berkeley) Ostro, S. (JPL) Yeomans, D. (JPL) Palmer, P. (Chicago) Snyder, L. (Illinois) Muhleman, D. (Caltech)	Radar observations of asteroids and comets. 3.8 cm line.
AD269	de Pater, I. (Berkeley) Romani, P. (NASA/GSFC) Atreya, S. (Michigan)	Uranus. 3.8, 6, 20 cm.
AD270	Dey, A. (Berkeley) van Breugel, W. (IGPP/LLNL)	Radio-loud far-infrared galaxies. 6 cm.
AD271	Dressel, L. (ARC)	Central star formation and AGN in SO galaxies. 20 cm.
ad hoc	Kellermann, K.	Structure of the BAL quasar 1700+518. 2 cm.
AE081	Eales, S. (Toronto) Rawlings, S. (Cambridge) Saunders, R. (Cambridge) Taylor, G. (UCLA)	Radio galaxies just below peak of source counts: $z > 4$ candidates. 3.8, 20 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AE082	Engels, D. (Hamburger Sternwarte) Winnberg, A. (Chalmers, Onsala) Lindqvist, M. (Chalmers, Onsala) Walmsley, C. M. (MPIR, Bonn) Schmid-Burgk, J. (MPIR, Bonn)	Water maser emission in circumstellar shells. 1.3 cm line.
AF209	Frail, D. Moffett, D. (NMIMT)	Crab-like supernova remnants. 6, 20 cm.
AF210	Frail, D. Wolszczan, A. (NAIC)	Accurate position for a new high latitude millisecond pulsar. 20 cm.
AF212	Fruchter, A. (Berkeley) Backer, D. (Berkeley) Goss, W. M.	Search for cluster pulsars. 20 cm.
AF213	Fernini, I. (New Mexico) Burns, J. (New Mexico State) Bridle, A. Perley, R.	Jet/counterjet ratio in 3CR radio galaxies. 6 cm.
AF214	Foster, R. (NRL) Backer, D. (Berkeley) Wolszczan, A. (NAIC)	Astrometry of pulsar PSR 1951+32 in radio nebula CTB 80. 20 cm.
AF215	Frail, D. Goss, W. M. Baldwin, J. (Cambridge)	Scintars: Potential pulsar candidates?. 6, 20 cm.
AG324	Gregory, P. (British Columbia) Scott, W. (British Columbia) Duric, N. (New Mexico) Taylor, A. (Calgary)	New variable galactic radio source with twin jets, GT2318+620. 2, 3.8, 6, 20 cm.
AG326	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Wehrle, A. (JPL)	Varying core of the radio galaxy 3C 338. 3.8, 6 cm.
AG328	Guedel, M. (Colorado/JILA) Benz, A. (SFIT, ETH)	High frequency dMe star radio emission. 2, 3.8, 6, 20 cm.
AG329	Garay, G. (Chile, U. of) Curiel, S. (CFA) Rodriguez, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia)	Non-thermal radio emission from the strings in Cepheus A? 6, 20 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AG330	Gomez, Y. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Moran, J. (CFA)	Water masers outside the OH velocity range in OH/IR stars. 20 cm line.
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.
AH390	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Monitoring radio novae. 3.8, 6, 20 cm.
AH424	Han, X. (NMIMT) Hjellming, R.	The radio remnant of the 1989 outburst of V404 Cyg. 3.8, 6 cm.
AH433	Hummel, E. (MPIR, Bonn) Quirrenbach, A. (NRL)	Kiloparsec scale structure of the peculiar S5-quasar 0153+744. 20 cm.
AH434	Hummel, E. (MPIR, Bonn) Quirrenbach, A. (NRL) Krichbaum, T. (MPIR, Bonn)	VLA and MERLIN observations of quasar 0836+710. 6 cm.
AH437	Hewitt, J. (MIT) Turner, E. (Princeton) Chen, G. (MIT) Angelus, A. (MIT)	Monitoring the Einstein Ring gravitational lens MG1131+0456. 3.5, 6 cm.
AH439	Hughes, V. (Queens)	Variability of HII regions in Cepheus A. 2, 6, 20 cm.
AI041	Impey, C. (Arizona) Foltz, C. (MMTO)	The radio structure of optically selected quasars. 6 cm.
AJ200	Jacobson, A. (Los Alamos) Erickson, W. (Maryland) Mercier, C. (Meudon)	Ionospheric dynamics. 90 cm.
AJ201	Jackson, N. (Manchester) Browne, I. (Manchester) Shone, D. (Manchester)	Structure and polarization of 0800+608. 3.8 cm
AJ202	Jackson, N. (Manchester) Browne, I. (Manchester) Gower, A. (Victoria)	Morphology of 0100+108. 3.8 cm.
AJ204	Jannuzi, B. (Princeton) Stoeck, J. (Colorado) Perlman, E. (Colorado) Elston, R. (KPNO)	Detecting radio jets in X-ray selected BL Lacs. 3.8 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AJ205	Johnston, H. (Caltech) Kulkarni, S. (Caltech)	Globular cluster pulsars. 20 cm.
AJ206	Junor, B. Salter, C. Saikia, D. (GMRT) Mantovani, F. (Bologna)	High frequency polarimetry of compact steep spectrum sources. 1.3, 2, 3.8 cm.
AJ208	Jackson, J. (Boston) Paglione, T. (Boston) Ho, P. (CFA)	NH ₃ imaging of W49 at 750 AU resolution. 1.3 cm line.
AJ209	Jones, D. (JPL) Murphy, D. (JPL) Meier, D. (JPL) Preston, R. (JPL) Jauncet, D. (Australia Telescope) Tzoumis, A. (Australia Telescope) Reynolds, J. (Australia Telescope) Perley, R. Rao, P. (GMRT)	Short-term monitoring of 1830-211. 3.8 cm.
AJ210	Johnston, K. (NRL) Gaume, R. (NRL) Wilson, T. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Menten, K. (CFA)	Size of the CH ₃ OH masers in Orion. 1.3 cm line.
AJ211	Johnston, H. (Caltech) Kulkarni, S. (Caltech) Goss, W. M.	High frequency observations of the planetary nebula K648 in M15. 3.8 cm.
AJ213	Johnston, H. (Caltech) Kulkarni, S. (Caltech) Verbunt, F. (Utrecht)	ROSAT X-ray sources in globular clusters. 20 cm.
AK233	Kundu, M. (Maryland) White, S. (Maryland) Maran, S. (NASA/GSFC) Woodgate, B. (NASA/GSFC)	Stellar coronal plasma and flares. 2, 6 cm.
AK270	Kronberg, P. (Toronto) Sramek, R.	Flux density monitoring of 30 brightest compact sources in M82. 2, 6 cm.
AK271	Kulkarni, S. (Caltech) Vasisht, G. (Caltech) Frail, D.	Interaction of pulsars with supernova shells. 20 cm

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AK272	Kassim, N. (NRL) Perley, R. Taylor, G. (UCLA) Erickson, W. (Maryland) Dwarakanath, K. (Raman Institute)	Synthesis of six strong radio sources at 4 m wavelength. 90 cm.
AK273	Kay, L. (Barnard) Antonucci, R. (Calif., Santa Barbara)	IRAS 20460+1925: A quasar with type II Seyfert properties. 3.8 cm.
AK274	Kenny, H. (Calgary) Taylor, A. (Calgary) Davis, R. (Manchester) Pavelin, P. (Manchester) Bode, M. (Preston/Lancashire) Bang, M. (Preston/Lancashire)	Inner geometry of symbiotic stars. 6 cm.
AK275	King, L. (Manchester) Browne, I. (Manchester) Patnaik, A. (Manchester) Walsh, D. (Manchester) Wilkinson, P. (Manchester)	Small separation gravitational lens candidates. 2, 3.8, 6, 20 cm.
AK276	Kollgaard, R. (Penn State) Holdaway, M. Burns, J. (New Mexico State)	Proper motion in the jet of Cen A. 6 cm.
AK277	Kolman, M. (Columbia)	Brightest radio quiet quasar. 1.3, 2, 3.8, 20 cm.
AK282	Kulkarni, S. (Caltech) Navarro, J. (Caltech) Tanaka, Y. (ISAS, Japan) Frail, D.	Quiescent LMXBs. 20 cm.
AK291	Kulkarni, S. (Caltech) Phillips, J. (Caltech) Vasisht, G. (Caltech)	Polarization monitoring of PSR 1829-10. 20 cm.
AK292	Knopp, G. (Wisconsin)	GW Orionis. 2, 3.6, 6 cm.
AL150	Lestrade, J-P. (JPL) Preston, R. (JPL)	RSCVn stars. 6 cm.
AL234	Leone, F. (Catania) Umana, G. (Catania)	Synoptic observation of CP2 (chemically peculiar) stars. 6 cm.
AL238	Ledlow, M. (New Mexico) Owen, F.	Properties and evolution of radio galaxies in rich clusters. 20 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AL239	Lang, K. (Tufts) Willson, R. (Tufts) Aschwanden, M. (NASA/GSFC) Benz, A. (SFIT, ETH)	VLA-Phoenix-GRO studies of solar bursts. 20, 90 cm.
AL240	Lang, K. (Tufts) Willson, R. (Tufts) Noto, J. (Tufts) Gelfreikh, G. (Pulkovo Obs.) Bogod, V. (Lebedev, Moscow)	VLA-RATAN 600 observations of noise storm-producing active regions. 90 cm.
AL242	Lehto, H. (Southampton, U. of) Johnsson, D. (U. College Cardiff)	R Aqr: proper motion and spectrum of radio components in jet and core. 3.8, 6 cm.
AL243	Lonsdale, C. (Haystack) Lonsdale, C. (IPAC, Pasadena) Smith, H. (Calif., San Diego)	Enigmatic radio source in the starburst galaxy Mkn 297. 1.3, 2, 3.8, 6, 20 cm.
AL244	Langston, G.	Variability of gravitational lens 2016+112. 3.8, 6 cm.
AL253	Liebert, J. (Arizona) Bieging, J. (Arizona)	Magnetic white dwarf. 3.8, 20 cm.
AM305	Molnar, L. (Iowa) Mutel, R. (Iowa) Deng, J. (Iowa)	A survey of interstellar scattering in the Cygnus X region. 20 cm.
AM327	McKinnon, M. (NMIMT)	Polarization of unpulsed radio emission from pulsars. 20 cm.
AM328	Mehringer, D. Palmer, P. (Chicago) Yusef-Zadeh, F. (Northwestern) Goss, W. M.	Search for H ₂ O and OH masers in Sgr B1. 20 cm line.
AM330	Marcha, M. (Manchester) Browne, I. (Manchester) Patnaik, A. (Manchester) Wrobel, J.	BL Lac objects and flat spectrum radio galaxies. 3.8, 20 cm.
AM331	Marscher, A. (Boston) Bania, T. (Boston)	Variable molecular absorption toward extragalactic continuum sources. 6 cm line.
AM332	Masson, C. (CFA) Lo, K. (Illinois) Killeen, N. (Australia Telescope)	Proper motions in the galactic center. 6 cm.
AM335	Menten, K. (CFA) Reid, M. (CFA)	The trapezium sources in the Orion Nebula. 1.3, 3.8 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AM336	Miley, G. (Leiden) Rottgering, H. (Leiden) Chambers, K. (Leiden)	Study of radio galaxies $z > 2$. 3.8, 20 cm.
AM337	Mirabel, I. (CNRS, France) Rodriguez, L. (Mexico/UNAM) Cordier, B. (CNRS, France) Paul, J. (CNRS, France) Lebrun, F. (CNRS, France)	VLA-Sigma observations of 1E 1740.7-2942. 3.8, 6, 20 cm.
AM339	Muhleman, D. (Caltech) Grossman, A. (Maryland) Butler, B. (Caltech) Slade, M. (JPL) Ostro, S. (JPL)	VLA/Goldstone radar mapping of Ganymede and Callisto. 3.8 cm line.
AM340	Muxlow, T. (Manchester) Saikia, D. (GMRT)	VLA, MERLIN, and VLBI 5 GHz observations of 3C 395. 6 cm.
AM341	Mundy, L. (Maryland) Sandell, G. (Hawaii) McMullin, J. (Maryland) Russell, A. (Hawaii) Aspin, C. (Hawaii)	Extremely young stellar system IRAS 4 in NGC 1333. 2, 3.8, 6 cm.
AM354	Molnar, L. (Iowa) Allen, J. (Iowa) Taylor, A. (Calgary) Kenny, H. (Calgary) Hjellming, R.	Monitoring a cycle of LSI +61 303. 1.3, 2, 3.8, 6, 20 cm.
AM355	Menten, K. (CFA) Alcolea, J. (CFA)	Nascent planetary IRAS 19114+0002. 20 cm line.
AO103	O'Donoghue, A. (St. Lawrence) Eilek, J. (NMIMT) Owen, F.	Spectral index observations of 3C 465. 90 cm.
AO105	Okorogu, A. (Nigeria) Akujor, C. (Nigeria) Garrington, S. (Manchester)	Radio jets without hotspots. 3.8, 20 cm.
AP115	Payne, H. (STScI) Terzian, Y. (NAIC)	NGC 6302. 18 cm.
AP209	Parijskij, Y. (Pulkovo Obs) Soboleva, N. (Pulkovo Obs) Temirova, A. (Pulkovo Obs) Goss, W. M.	RATAN-600 sources. 6 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AP210	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A.	Twenty-one optically selected quasars at 1.3 cm wavelength. 1.3 cm.
AQ005	Quirrenbach, A. (NRL) Standke, K. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn)	VLBI phase reference sources for the QSO 0917+624. 3.8, 6 cm.
AQ006	Quirrenbach, A. (NRL) Wegner, R. (MPIR, Bonn) Witzel, A. (MPIR, Bonn)	Jet and halo of BL Lacertae object 0716+714. 6 cm.
AR220	Reid, M. (CFA) Silverstein, E. (CFA)	OH masers and the galactic magnetic field. 20 cm line.
AR242	Rucinski, S. (York U.)	Close binary ER Vul. 2, 3.8, 6, 20 cm.
AR244	Reid, M. (CFA) Menten, K. (CFA)	Direct measurement of the size and temperature of Mira variables. 1.3 cm.
AR247	Roberts, D. (Brandeis) Hewitt, J. (MIT) Herold, L. (MIT) Burke, B. (MIT)	Gravitational lens 0957+561. 2, 3.8 cm.
AR248	Rowan-Robinson, M. (Queen Mary) Broadhurst, T. (Queen Mary) Lawrence, A. (Queen Mary) Lonsdale, C. (IPAC, Pasadena) McMahon, R. (Cambridge) Condon, J.	Luminous, $z = 2$, emission line galaxy IRAS 10214+4724. 3.8, 20 cm.
AR257	Reynolds, R. (Wisconsin) Lockman, F. J. Langston, G.	HI absorption toward globular clusters. 18, 20 cm line.
AS333	Sramek, R. Weiler, K. (NRL) van Dyk, S. (NRL) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6 cm.
AS410	Simonetti, J. (VPI & SU) Dennison, B. (VPI & SU) Dickey, J. (Minnesota)	Search for time variation in galactic HI absorption. 20 cm line.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AS430	Seaquist, E. (Toronto) Taylor, A. (Calgary) Krogulec, M. (Toronto) Weston, D. (York U.)	A survey of symbiotic stars. 3.8 cm.
AS438	Sparks, W. (STScI) Macchetto, F. (STScI) Miley, G. (Leiden)	3C 66B: a double stranded optical jet. 1.3, 2 cm.
AS442	Slade, M. (JPL) Butler, B. (Caltech) Jurgens, R. (JPL) Muhleman, D. (Caltech)	Dual-polarized radar mapping of Mercury. 3.8 cm line.
AS446	Spinrad, H. (Berkeley) Dickinson, M. (Berkeley) Dey, A. (Berkeley) van Breugel, W. (IGPP/LLNL)	High redshift radio galaxies from the MIT/GB surveys. 3.8, 20 cm.
AS448	Schmid-Burgk, J. (MPIR, Bonn) Mauersberger, R. (MPIR, Bonn) Schilke, P. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Johnston, K. (NRL) Gaume, R. (NRL)	Molecular outflows and water masers in the core of OMC-1. 1.3, 3.8, 20 cm line.
AT114	Taylor, A. (Calgary) Dougherty, S. (Calgary)	Monitoring of radio variable Be stars. 3.8 cm.
AT117	te Lintel Hekkert (Mt. Stromlo) Wood, P. (Mt. Stromlo) Whiteoak, J. (Australia Telescope)	OH/IR stars in M31. 20 cm line.
AT124	Thorsett, S. (Princeton) Taylor, J. (Princeton) Stinebring, D. (Oberlin) Hankins, T. (NMIMT)	Timing fast pulsars at the VLA. 6, 20 cm.
AT125	Tang, G. (CFA) Lonsdale, C. (Haystack) Bartel, N. (CFA)	Primary hotspots in FR II sources. 2 cm.
AT126	Taylor, G. (UCLA) Hu, E. (Hawaii)	Quasar and Lyman- α companion in 1033+137. 20 cm.
AU042	Ulvestad, J. (JPL) Antonucci, R. (Calif., Santa Barbara)	Compact radio sources in NGC 253. 1.3, 2, 3.8, 6 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AU043	Ulvestad, J. (JPL) Antonucci, R. (Calif., Santa Barbara) Goodrich, R. (Caltech)	Three narrow-line Seyfert 1 galaxies. 3.8 cm.
AV188	van der Hulst, J. (Groningen/Kapteyn) van Gorkom, J. (Columbia)	Cen A HI absorption. 20 cm line.
AW249	Wills, B. (Texas) Shastri, P. (Texas)	Core variability in lobe-dominated quasars. 6 cm.
AW278	Wilson, A. (Maryland) Dressel, L. (ARC)	Radio mapping of active galaxies to be imaged with the HST. 3.8 cm.
AW284	Walker, R. C. Benson, J.	Superluminal motion at 4 arcseconds in 3C 120. 6 cm.
AW285	Walker, R. C. Wilkinson, P. (Manchester)	Large scale structure in 3C 48. 3.8, 20 cm.
AW288	Waldron, W. (ARC)	Radio emission from early-type stars: Measure of local X-ray absorption. 3.8 cm.
AW292	Wolfe, A. (Calif., San Diego) Brinks, E. Garwood, R. Briggs, F. (Pittsburgh)	Search for 21 cm absorption in damped Lyman- α system towards MG 0201+11. 90 cm line.
AW293	Wood, D. Churchwell, E. (Wisconsin)	OH maser emission associated with ultracompact HII regions. 20 cm line.
AW294	Wood, D. Churchwell, E. (Wisconsin)	Gas dynamics and physical properties in ultracompact HII regions. 3.8 cm line.
AW295	Wilson, T. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Schilke, P. (MPIR, Bonn) Walmsley, C. (MPIR, Bonn) Johnston, K. (NRL) Gaume, R. (NRL)	Size and peak brightness temperature of (J,K)=(9,8) ammonia maser in W51. 1.3, 3.8 cm line.
AY037	Yusef-Zadeh, F. (Northwestern) Cornwell, T.	HH-like streamers in Orion. 3.8, 6, 20 cm.
AY043	Yusef-Zadeh, F. (Northwestern)	High resolution mosaic of the Sgr A complex. 3.8 cm.
AY044	Yin, Q-F. Xu, L. (Beijing Obs.) Heeschen, D.	Nearby starburst galaxies. 3.8 cm.

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
AY045	Yin, Q-F. Heeschen, D.	Supernovae in MKN 297. 3.6, 6, 20 cm.
AZ044	Zhao, J-H. Ekers, R. (Australia Telescope) Goss, W. M. Lo, K. (Illinois) Narayan, R. (Arizona)	Flux density variations in Sgr A. 3.8, 6, 20 cm.
AZ051	Zensus, A. Porcas, R. (MPIR, Bonn)	Flux measurement of 8 quasars in an orientation unbiased sample. 2, 3.8 cm.

E. VERY LONG BASELINE ARRAY

<u>No.</u>	<u>Observer(s)</u>	<u>Program</u>
BK001	Kemball, A. Diamond, P.	Mapping the circumstellar structure of OH 17.7-2.0. 20 cm.

F. SCIENTIFIC HIGHLIGHTS

Socorro

Asteroid Radar - Radar returns from the two asteroids 1991 EE and Bamberga were successfully received by the VLA with the help of X-band signals transmitted by the 70 m Deep Space Network antenna at Goldstone, California. With the VLA in its A configuration, the observations of both asteroids suffered from near-field effects on the longer baselines, and so it will not be possible to create unblurred images until the proper software is developed. The heavily tapered image of Bamberga does show, however, a displacement of 2.1 arcseconds from the position derived from optical observations between 1905 and 1985. Spectral resolution was sufficient only to discern that Bamberga has an elongated shape.

Investigators: Imke de Pater (Berkeley), Patrick Palmer (U. Chicago), Lewis Snyder (U. Illinois), Steve Ostro (JPL), Don Yoemans (JPL)

Snake Near Galactic Center - High resolution imaging of a peculiar feature near the Galactic Center has been cooperatively obtained with the VLA, the Molonglo Observatory Synthesis Telescope (MOST), and the Australian Telescope Compact Array (ATCA). The sinuous feature, first identified on a MOST Galactic Center survey at 843 MHz, is morphologically similar to the class of objects known as "threads" that have been previously imaged in the region with the VLA. The feature, only 10 arcseconds wide but extended fully 20 arcminutes in length, is kinked slightly at two locations along its length. The brightness distribution along the axis of the feature varies smoothly and continuously, increasing from either end to a peak near its midpoint. The VLA 20cm continuum observations helped determine that the object has a non-thermal spectrum with index -0.5, similar to that of other known threads or filaments. Unlike previously known linear features, however, the Snake does not appear to be obviously connected with any active region that might be responsible for its generation.

Investigators: A. D. Gray (U. of Sydney), L. E. Cram (U. of Sydney), R. D. Ekers (Australia Telescope), W. M. Goss (NRAO)

Detection of H92 α from Symbiotic Star - The first detection of a radio recombination line (RRL) from a symbiotic star and only the second detection of an RRL from a stellar object was recently accomplished with the VLA. Symbiotics are complex and poorly understood systems believed to be binaries containing a late-type giant star, a hot component, and an ionized nebula. The giant component drives a cool, massive wind. The hot component, a hot white dwarf or a subdwarf with $T_e \sim 10^5$ K, produces an intense flux of ultraviolet photons which create an ionized cavity in the cool wind. The ionized cavity in the slowly expanding wind is somewhat analogous to an ultra-compact HII region. The VLA was used to detect the H92 α RRL using the 2 IF mode spectral line system at a frequency of 8309.383 MHz from the symbiotic H1-36 Arae, one of the most extreme members of the symbiotic class. The cool component of H1-36 has a mass loss rate estimated to be \dot{M} approximately $3 \times 10^{-5} M_\odot$ per year and an extraordinarily slow wind speed of approximately 10 km per second. The distance between the hot and cool components is approximately 4×10^{16} cm.

Investigators: T. Bastian (NRAO), J. van Gorkom (Columbia), K. Anantharamaiah (Raman Research Institute)

Green Bank

Discovery of New Methanol Maser Transition - The 140 Foot Telescope was recently used to observe the 6.6 GHz transition of methanol. The goal was to understand the excitation mechanism of interstellar masers, a twenty-year pursuit already. The supposition was that this particular transition would be seen in absorption and that would help reveal the population of various energy levels in this complicated molecule. Instead, the transition turned out to be masing. In fact, spectral lines second only in strength to some water maser lines were detected. The masing methanol is widespread: its presence was detected in approximately 80 galactic regions. This was a line that radio astronomy technology could have discovered 25 years ago. That the second strongest line escaped detection for this long indicates how poorly studied the centimeter wavelength band is. This bodes well for the future of the Green Bank Telescope.

Investigator: Karl Menton (Center for Astrophysics)

Tucson

A study of the mechanism by which an embedded young stellar cluster may alter the chemistry of its surrounding cloud has been made.

A determination has been made of the abundances of 19 molecular species in three different dense cores in the ρ Oph cloud. Harboring an embedded cluster, the cloud is the most productive, in terms of star-forming efficiency, known (Wilking 1989). Not only is the efficiency highest of any known cloud (exceeding the Taurus cloud efficiency by an order of magnitude or more), but the star formation has occurred on timescales much shorter than in Taurus (Wilking 1989). Despite this, the curious apparent enhancement of carbon-chain species in the Taurus clouds has been attributed to a particularly juvenile chemistry. The abundances of various species has not been well-determined until now in the Oph cloud complex. The study covers a dozen particularly dense cores at various locations with assorted star-forming histories around the complex. For six of the species studied, (CS, SO, HCN, HNC, HCO^+ , and H_2CO) the abundances are determined from the ^{13}C or ^{34}S substituted species because of the high optical depth of the dominant isotopic species. In addition, abundances of five deuterium substituted species have been determined because the ratio of the deuterated to dominant isotope is especially revealing of the chemistry of cold core regions. In most of the abundance determinations multi-transition data has been obtained so that the molecular excitation and abundances could be determined without having to resort to unwarranted assumptions.

Preliminary reductions of these observations reveal a pattern of relative depletion of hydrocarbon molecules. For example, even in the ρ Oph core with the largest value of the $\text{X}(\text{HC}_3\text{N})/\text{X}(\text{HCN})$ abundance ratio, this ratio is two orders of magnitude less than found in the cold core in TMC-1. The abundances of C_3N , C_4H , and C_3H_2 also reveal depletion of hydrocarbons. The abundance of CCH in the currently available data appears to be depleted by an order of magnitude. Unlike the depletion pattern of hydrocarbon abundances, the abundances of SO, SO_2 , CH_3OH , HCO^+ , and to a lesser extent N_2H^+ are enhanced relative to what is seen in the TMC-1 cloud. Particularly interesting is the order-of-magnitude enhancement of the SO and SO_2 molecules near GSS30, a binary near the Oph A molecular core. Using the very sensitive new 3 mm receiver at the 12 Meter Telescope, we have been able to show that emission from SiO, at least in the $J = 2-1$ line, is strong at this

position. These results suggest, particularly in the specific GSS30 case, that oxygen has been enhanced in the gas phase. Increased abundances of such heavy molecules suggests that the source of the enhancement may be the release of grain mantle constituents. Interferometric observations of SO support this conclusion, revealing that the enhancement is localized entirely to the two components of GSS30. These results clearly indicate a larger elemental oxygen/carbon ratio in the ρ Oph cloud cores compared to the TMC-1 core. They suggest that even moderate luminosity stars may cause release of atoms and molecules frozen to grains in amounts substantial enough to alter cloud chemistry.

Investigators: R. B. Loren (unaffiliated), H. A. Wootten (NRAO)

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

The production of 12-18 GHz, 21-25 GHz, 26-36 GHz, and 38-45 GHz amplifiers continued. A summary of amplifier deliveries in this quarter is given in the table below:

FREQUENCY BANDS	NUMBER OF AMPLIFIERS
12-18	14
21-25	4
26-36	5
38-45	3
Grand Total	26

A preliminary study of HFET's from the point of view of mmA needs (RF, IF, and LO) has been performed (mmA Memo No. 67).

Superconducting (SIS) Millimeter-Wave Mixer Development

The CDL has now built and supplied new modular SIS receivers to the 12 Meter Telescope for the 4 mm, 3 mm, 2 mm, and 1.3 mm bands. We have not yet completed the two spare receivers for all the bands. In the lab we have now achieved receiver noise temperatures under 30 K (DSB) over most of the 3-mm band, and under 50 K over most of the 1.3 mm band, and it is hoped to equip the telescope with these mixers in the near future.

Two new sets of SIS mixers have been designed. The first, still in fabrication at UVA, contains mixers primarily for 200-300 GHz, including *fixed-tuned* mixers for the planned eight-beam 230 GHz SIS receiver, and a few tunable mixers for 130-170 GHz. The second set, containing small chip and integrated (tunerless) designs specifically for the 130-170 GHz bands, is now at the mask-maker. These two new sets contain 2,652 mixers of 78 different designs.

Work continues on the new, more versatile, SIS mixer test set based on a closed-cycle JT refrigerator. The new test set will allow us to measure the conversion loss and noise of new experimental mixers of various sizes and configurations (including 4 K feed horns and lenses, if desired) which will not fit in our present small liquid helium test cryostats.

During this quarter we have built (or rebuilt) and tested a total of three SIS mixers operating from 68-260 GHz. In addition, we have mounted and evaluated 13 experimental monolithic GaAs frequency multipliers made at Martin-Marietta Labs. Such multipliers may play an important role in the local oscillator chain on the mmA.

OVLBI Earth Station Project

The results of the preliminary design phase, concluded last quarter, were given in a written report and in oral presentations at a formal review meeting held in Green Bank on July 2. The meeting was attended by five representatives from JPL, one from NASA Headquarters, and six from NRAO (excluding project personnel). A three-person review board produced a summary of the meeting and a list of action items and recommendations.

A M.S.-level engineer was hired to fill the one remaining open position in the project; he is scheduled to start work during October. This brings the technical team to five full-time persons, which should be sufficient to complete the project.

Most of the quarter was devoted to beginning the detailed design of various subsystems. These include the feed/optics system, the two-way timing system, and the computer control system.

Electromagnetic Support

A mode-matching program installed on a Sparc station was tested for its accuracy and debugged. Using this program, the GBT L-band profile horn was designed. The feed was scaled to C-band for building the prototype.

A beam-switching concept using a pair of reflectors was worked out for operation at X-band and above on the GBT. In order to analyze the effect of the structure in the vicinity of the subreflector of the GBT, the amount of power in the feed pattern that is outside the subreflector was calculated and critical regions were identified.

On the VLBA antenna, rear spillover was calculated for different feed tapers and feed rotations for various elevation angles of the antenna, in order to account for the extra spillover that was measured at low elevations with the dichroic reflector in front of the S-band feed.

I. GREEN BANK ELECTRONICS

Green Bank Telescope

A draft plan for gregorian receivers for the GBT was completed and distributed for technical review within NRAO. The plan provides for continuous frequency coverage from 1.15 to 50 GHz in 15 receivers. An approach to generating circular polarization at each frequency has been selected. A similar plan is in preparation for the prime focus receivers.

NRAO's proposal to change the design of the receiver room has been accepted by RSI. The old design included a two-story hut with a radome over the selected feed. The new plan has the feeds protruding through the roof of a one story building. This eliminates possible reflection problems off the radome. However, now the edge of the turret has to be weather tight.

A study of prime focus feed taper resulting in optimization of G/T was completed. It was concluded that the best taper is in the 20-22 dB range, which is several dB higher than the usual on existing antennas. With low receiver temperatures and the absence of scattered noise, the spillover noise is a more significant contributor to the total system noise than has been true

in the past. Based on these results and the working feed envelope restrictions being used, it appears that corrugated horn type feeds can be used down to about 600 MHz.

A study of the constraints on the IF transmission system imposed by the fiber optic transmitters and receivers has begun. Dynamic range and noise performance of available devices are currently being evaluated.

Progress continued on the GBT active surface design. Bids were received and evaluated for the three major components of the actuators: the actuator itself, the associated motor, and LVDT. Final details of contracts with vendors for each of these components are presently being negotiated. 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. During this quarter testing of various sample LVDT's and associated cables and electronics was completed and the results analyzed. Four of six vendors provided LVDT's which were adequate for our requirements. Development of a laser ranging instrument to measure the telescope's surface and pointing continues. The goal is to use three "second generation" instruments together to locate points in three dimensions. One of these instruments has been built and tested. The two others are nearly complete. Development of test and analysis software for this system continues.

Autocollimators will be used on the GBT to measure and correct for pointing errors introduced by the foundation, track, and alidade structure. Tests of an autocollimator in an outdoor range continued during the quarter. A tube was constructed to house the beam in an effort to decrease the time variability of the measured angle.

A holographic technique will be used to measure the surface accuracy of the GBT. The proposed system will use Ku band satellites as sources, use the gregorian focus, and have the reference antenna mounted on the feed arm. During this quarter, one high speed A/D board was prototyped and two others constructed. The timing control and signal processing boards were designed and constructed.

Interferometer Upgrade

During this quarter a bandwidth upgrade in the S/X receivers was completed. X-band now covers 8213 to 8937 MHz and X-band 2221 to 2350 MHz. Also, an IF selection system which permits a variety of IF's from the 85 foot antennas to be sent to the 140 foot for analysis by the spectral processor has been designed, and parts are on order. Finally, construction of modules for the VLBA terminal for the USNO Hawaii antenna continues.

140 Foot Telescope Cassegrain Receivers

During this quarter testing of components for the second LO system continued.

Miscellaneous

Construction of receivers for the VLBA continues. The first eight S-band receivers have been shipped to date, and the final three are almost fully constructed. The fifth 43 GHz receiver is under test, while number six is under construction and number one is being reworked. An upgrade to the Green Bank LAN has been started with the outfitting of all offices on second floor of the Jansky Labs for thin ethernet.

J. VLA ELECTRONICS

RFI Improvements

Construction of a prototype B rack shield 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 all remaining units installed this quarter for a total of eight enclosures. This quarter four more units have been placed on order. The remaining enclosures will be constructed and installed if funding permits.

1.3-1.7 GHz T_{sys} Improvements

Presently eight VLA antennas have the improved VLBA style L-band 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.

K. 12 METER TELESCOPE

New 3 mm SIS Receiver

The new 3 mm SIS receiver has been completed and is now in service on the 12 Meter Telescope. This is a dual polarization receiver covering two frequency bands, 68-90 GHz and 90-115 GHz. Receiver noise temperatures are typically 80-90 K throughout either band. This is the first SIS receiver at the NRAO covering the 68-90 GHz band, and offers a dramatic improvement in sensitivity compared to the Schottky receivers previously in use. In addition, this receiver is substantially more sensitive than the old SIS receiver covering the 90-115 GHz band.

This receiver package features several innovations that have contributed to the improved sensitivity and versatility of the system. The cryostat currently contains four SIS receivers (two for each band), but is designed to house up to eight. In the future other receivers, such as those covering the 130-170 GHz band, may be contained in this same cryostat. The cryostat is cooled by a 4 K, closed-cycle, Joule-Thomson circuit. The optics are cooled to cryogenic temperatures, thus lowering their contribution to receiver noise temperature. This receiver is tuned by computer. In addition to its service at the 12 Meter, this receiver concept is a prototype for Millimeter Array receivers.

The mixers for this receiver were developed at the Central Development Laboratory, and the receiver and tuning packages were developed in Tucson.

Hybrid Spectrometer Upgrade

An upgrade of the hybrid spectrometer high resolution mode has been finished and is nearly ready for release at the 12 Meter Telescope. The original design of the hybrid spectrometer could support (at least) dual polarization I.F.'s at all bandwidths from 600 MHz down to 37.5 MHz. However, to achieve the highest resolution mode of 24 kHz per channel, observers had to place all 1536 spectral channels across one polarization I.F. For certain high resolution experiments, this was a distinct drawback, since one could not average polarization channels in this mode. Because of the narrow channel bandwidths involved, observers need all the sensitivity at their disposal. In the upgrade just finished, observers can now achieve 24 kHz resolutions at 12.5 MHz bandwidths in both orthogonal polarization channels.

Control System Upgrade

Phase II of the control system upgrade project has been completed. Last year, the Tucson staff replaced the old FORTH system in use at the telescope for over 15 years with a modern, distributed-processing system written in the C language and running on mostly modern hardware. However, the host computer for the system was an older generation VAX 11/750, which was retained because a number of hardware devices were connected directly to it through specialized interfaces. The staff has now converted all the older hardware to modern VME interfaces, and has replaced the VAX with a Sun Workstation running under the Unix operating system. Observers have already noticed a significant improvement in the efficiency of the new system. In addition, the new system is simpler and easier to maintain than the VAX-based system. Because of the design architecture of the new system, it has nearly limitless capacity for expansion to handle, for example, multibeam receivers, large backends, and the associated higher data rates that are anticipated over the next few years.

L. AIPS

The 15APR91 release of AIPS appears to be relatively free of bugs. We have also heard good reports of our distribution of AIPS via File Transfer Protocol (FTP). The 15JAN91, 15APR91, and 15JUL91 AIPS LETTERS were completed and sent in one combined packet. In the LETTERS, it is announced that AIPS documentation and a few source code patches are available via FTP. The next release of AIPS will be 15APR92; the AIPS LETTERS will continue to be released quarterly.

There have been significant improvements in AIPS handling of VLBI software, especially spectral line full polarization observations. The software needed for the VLBA experiments should be ready before the VLBA is fully operational.

The new AIPS will be called aips++, and the old AIPS will still be called AIPS. In order to devote more effort to development of the new aips++ software, modifications to AIPS have been kept to a minimum. Considerable progress has been made in creating image and UV data classes in C++. Coding and documentation style standards are in preparation. Office space has been set aside for aips++ system designers from other institutions. These scientists will arrive in Charlottesville in early 1992.

The present state of AIPS is generally good, but a few outstanding problems remain:

A change is in progress to improve the handling of AIPS frequency tables in order to allow different types of spectral line observations. These changes are particularly needed for the Australia Telescope and are valuable for the VLBA project. Most of the AIPS UV data handling routines will be effected, but the change is relatively simple to implement.

The ability to read Exabyte and DAT tapes was added to the 15APR91 release of AIPS, but a few problems remain. The variations of the UNIX handling of I/O has made it difficult to create a single set of tape handling software.

Nagging problems still persist concerning the speed and complexity of the AIPS TV implementation for work stations.

M. VLA COMPUTER

Work on the near-real-time visualization project at the VLA site continued during this quarter. The SPARCstation-2 purchased for this purpose has been installed at the AOC and will be moved to the site in the near future. Using simulations of data streams from the Modcomps, the team has been able to fill data in real time using modified versions of both AIPS and ISIS.

The Ingres database package was installed on the Solbourne 5/801 server at the AOC, and substantial progress has been made in creating a new maintenance database program. This is the utility used by all VLA and VLBA maintenance staff at NRAO/NM to update and retrieve information on the status and location of all modules, parts, computers, and other equipment involved in the operation of the telescopes. Moving the database from a VMS platform to a UNIX one affords us the opportunity to redesign the system and correct flaws which have become apparent in the original program. Significant input has been received from numerous technicians and engineers who use the current program regularly, and the features and capabilities of the new version are continually being tested and improved. Although maintenance of the package will be an ongoing task, the bulk of the implementation should be complete early in 1992.

During the summer, the initial Request For Comments relating to the VLBA Construction computer procurement was issued. Of the roughly 150 companies which replied to the initial advertisement, approximately 40 responded to the RFC. Their comments are being taken into consideration during preparation of the final Request For Proposal documents. Two of an anticipated total of six RFPs for various classes of computing equipment were issued in late September. A number of Computer Division employees are members of the technical committees formed earlier this year to prepare specifications and evaluate the technical merit of the proposals received.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The first five VLBA stations are operational: Pie Town NM, Kitt Peak AZ, Los Alamos NM, Fort Davis TX, and North Liberty IA. The Owens Valley CA, station is operable, and participates in Network observations on an a "best efforts" basis until fully staffed, which is scheduled for the last quarter of 1991. The Brewster WA, station is operable, and participates in Network observations on a "best efforts" basis until it also is fully staffed in the next quarter.

At the Hancock NH, station antenna erection was completed in July 1991. Electronic outfitting at Hancock is underway. Its operability is scheduled for the next quarter. At St. Croix VI, the antenna erection is essentially complete. Outfitting of this station is scheduled to start in January 1992. Operability at St. Croix is scheduled for the second quarter of 1992. At Mauna Kea HI, the construction of the antenna foundation is complete and the control building is scheduled for completion in the last quarter of 1991. Antenna erection is scheduled to start in October 1991 and outfitting should be complete before the end of 1992.

Electronics

Construction of front ends, modules and Data Acquisition racks has continued this quarter. Final design modifications have been made to the 610 MHz filter module and the converter module for the new 14 GHz front end. The remaining work load to complete electronic construction for the project has been reviewed, and plans indicate that the last units will be finished by about the third quarter of 1992.

During this quarter installation of electronics on the antenna at Hancock was started and largely completed. The equipment for the antenna at St. Croix was sent to Socorro and has been prepared for shipment to the site during November. During September, hydrogen maser serial 11 was returned to Sigma Tau Inc. for repair (under warranty) because of excessive rate of decay of the IF signal and maser serial 7, which had been sent back for repair of a palladium valve, was returned to Socorro.

Data Recording

VLBA recorders through serial #21 (including two parts kits assembled at the AOC) have been shipped from Haystack Observatory. Deliveries from third production run (of eleven) through serial #32 are expected to start in the fourth quarter of 1991, with shipment intervals of approximately two weeks. A unit from the second run was delivered in August 1991 to the Astro Space Center in the USSR for a one-year loan to allow their staff to develop the necessary interfaces to ground stations for the Radioastron satellite, as well as earth-based VLBI antennas in the Soviet Union. A change order to Haystack for a fourth and last run of 11 recorders is expected to be placed in October 1991. Eight additional recorders are scheduled for production at the AOC in 1991 and 1992, in addition to the two recorders currently being completed at the AOC.

Field tests of samples of thin tape from various manufacturers were performed during the last two quarters. These tapes were mixed into VLBI and JPL/GSFC Network tape supplies for participating observatories and processing sites. Durability, magnetic and mechanical performance were monitored. Extensive laboratory tests were also performed at Haystack Observatory under various tape speeds and various values of other transport parameters. It is likely that a modification of some of the tape control surfaces in the recorder will be needed to prevent friction damage of the thin tape. A recommendation from Haystack on the choice of an initial operational tape purchase is expected in the next quarter.

Monitor and Control

During third quarter 1991, we have continued to enhance the on-line software system. We have worked on making the constant checks produce more meaningful information about equipment not performing as specified. A real-time fringe program is now available, using the formatter data buffer to capture a data stream. The tapes for the first VLBA format interferometer experiment have been written and sent to the Charlottesville correlator.

Internet communications seem to have settled down pretty well. The difficult protocol problem that we had with Owens Valley (the vxWorks operating system was limiting the number of network hops its messages could make) has finally been resolved, and communications with Brewster were established promptly when the various telephone and network connections were made. Groundwork has begun for establishing network connections to Hancock and St. Croix. A network communications backup plan is under development.

Work has started on upgrading our vxWorks operating system from version 4.0 to version 5.0. The driving factor behind this is for security purposes. Version 4.0 is not only insecure in itself, but makes security more difficult in attached systems.

A more or less complete set of the real-time screens was generated to run under the DOS operating system, on PCs (but only one screen at a time, instead of multiple ones as is done under vxWorks).

Correlator

Integration of hardware elements continued, while the focus of effort shifted increasingly to testing as the quarter progressed. A second round of system tests was completed, and further modifications were executed in the primary correlator rack. The second and third of the four racks were completed to this same standard. The second was installed, populated with hardware modules, and checked out.

Two long-term hardware developments were completed. On-board microprocessor firmware for the deformatter module, which has now been checked out in a stand-alone mode, and design of the digital output filter, for which a completed wirewrap panel was received on the last day of the quarter.

System-level hardware testing progressed in complexity from basic communications on the hardware control bus to nearly end-to-end cases using simulated playback drive signals from a specialized test fixture. These tests have established that the correlator proper--including the FFT, cross-multiplier, and integrator--functions as designed and as anticipated based on earlier simulations, across the entire half-system currently available for testing. Some unexplained anomalies, which must lie either in the playback Interface or in the playback drive simulator, are still under investigation. It has not yet been possible to perform tests using data reproduced from tape, nor to perform any joint tests of the hardware under control of the real-time software. As previously reported, however, the latter has been extensively tested in stand-alone simulations.

In the real-time control software, a new subsystem of "array" tasks was completed. These tasks supervise all aspects of data flow in the correlator's back end, from the output of the cross-multiplier after short-term accumulation, through the integrator and output filter, and into the archive. They include a FITS writer utility, started and finished during the quarter, which writes output files using the new FITS standard already agreed between the correlator and postprocessing groups. The continuing development of job control and job scheduling tasks is about half complete.

Several "as-late-as-possible" procurements were initiated for remaining components of the archive and distribution systems: large disk drives to buffer the data transfer for both processes and a first 8-mm "Exabyte" distribution drive. A survey of prospective VLBA users was begun to assess the community's preferences among the several technologies currently considered suitable for distribution of VLBA correlator output. The final procurements of distribution devices will be determined by this survey.

Observations to be used in the first correlator tests from tape were requested and completed during the final week of the quarter. These were the first VLBA observations made using the VLBA tape format. Preliminary playback tests indicate that many aspects of the format are being processed correctly both in the VLBA station's formatter and in the correlator's playback interface.

Data Processing

Over the last quarter the group has concentrated on two aspects of the postprocessing software:

(1) The tasks to read and write the new VLBA archive/distribution format were completed and tested within the AIPS environment. Tests are underway at this time to verify that we can read files written by the correlator group in this format. Preliminary results are very encouraging.

(2) We have also been testing the calibration and analysis software within the AIPS system. Small (and few) bugs have been found and fixed.

The group has spent some time defining the next stage of the testing of the software. We need to be able to compare the results of the AIPS fringe fitting software with those obtained from the Haystack software on the same data sets. This task will be undertaken in the next quarter.

O. PERSONNEL

New Hires

Palmer, P. E.	Visiting Scientist	07/01/91
Levin, B. J.	Electronics Engineer I	07/01/91
Porcas, R. W.	Visiting Scientist	07/22/91
Adler, D. S.	Asst. Scientist, Research Support	08/22/91
Latter, W. B.	Research Associate	09/10/91
Kislyakov, A. G.	Visiting Scientist	09/16/91
Dwarakanath, K. S.	Research Associate	09/23/91

Terminations

Palmer, P. E.	Visiting Scientist	07/31/91
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