NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

April 1, 1985 - June 30, 1985

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the second quarter of 1985.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1649.00	1861.25	1920.5	1707.8
Scheduled maintenance and equipment changes	136.00	203.75	103.5	214.4
Scheduled tests and calibrations	326.75	119.00	160.0	261.8
Time lost	71.25	21.50	198.0	
Actual observing	1577.75	1839.75	1722.0	1590.0

B. 140-FT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-76	Anantharamaiah, K. (Raman Inst.) Lockman, F. J.	Observations at 9 cm to study recombination lines from the galactic plane.
B-405	Brown, R.	Observations of recombination lines toward 3C 245 over a range of wavelength near 3.5 cm.
B-418	Bell, M. (Herzberg Inst.) Seaquist, E. (Toronto)	Observations at 1.5 cm to search for recombination lines in extragalactic sources.
C-218	Clark, F. (Kentucky) Turner, B.	Observations of bi-polar flows from young stars using OH in a probe.
C-227	Clark, F. (Kentucky) Bridle, A.	Observations of the interstellar medium near SS 433 and W50, using OH.
L-159	Lockman, F. J.	A deep systematic recombination line survey at 3 cm of continuum sources in the galaxy.

No.	Observer(s)	Program
L-195	Lockman, F. J. Hobbs, L. (Chicago) Jahoda, K. (Wisconsin) McCammon, D. (Wisconsin)	Observations to study HI in low column density directions.
M-234	Magnani, L. (Maryland) Blitz, L. (Maryland) Armus, L. (Maryland) Hoban-Magnani, S. (Maryland)	Observations at 21 cm and 18 cm of high latitude molecular clouds of HI and OH emission.
R-190	Rodriguez, L. (Mexico) Torrelles, J. (Mexico)	Observations at 8665 MHz for 3He+ hyperfine transitions in HI regions.
R-207	Rood, R. (Virginia) Wilson, T. (MPIR, Bonn) Bania, T. (Boston)	Observations at 8.7 GHz of the hyperfine transition of 3He+ in several galactic HII regions and planetary nebulae.
T-188	Turner, B. Rickard, L. (Howard)	Observations at 18 cm of anomalous OH emission and structure in M31.
T-192	Turner, B. Ziurys, L. (Massachusetts)	Observations at 11 cm to study the excitation of ground state interstellar CH.

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

A - Arecibo 1000-ft
B - Effelsberg MPIR 100-m
F - Fort Davis 85-ft
G - Green Bank 140-ft
H - Hat Creek 85-ft
I - Iowa 60-ft
Jb - Jodrell Bank MK II
Jm - Jodrell Bank 250-ft
Jn - Jodrell Bank Merlin
Km - Haystack 150-ft
Lb - Bologna 25-m
Lm - Medicina 32-m
N - NRL Maryland Pt 85-ft
O - Owens Valley 130-ft
R - Crimea USSR 30-m
So - Onsala 25-m
T - Torun 15-m
Wn - Westerbork n=1-2=14x26-m
Yn - Socorro n=1-27x25-m

No.	Observer(s)	Program
A-9V	Alef, W. (MPIR, Bonn) Pauliny-Toth, I. (MPIR, Bonn) Preuss, E. (MPIR, Bonn) Kellermann, K.	Observations at 6 cm of the structural variability in 3C 390.3 and 3C 111, with telescopes B, G, Km, Lb, O, So, Wn, and Yn.

No.	Observer(s)	Program
B-61V	Booth, R. (Onsala) Diamond, P. (MPIR, Bonn) Dennison, B. (VPI & SU)	A statistical survey at 18 cm of interstellar scattering in OH masers, with telescopes B, G, Jb, Km, O, So, and Yn.
B-62V	Baath, L. (Onsala) Booth, R. (Onsala) Matveyenko, L. (IFSR, USSR) Pauliny-Toth, I. (MPIR, Bonn)	Observations at 18 cm of the inner milliarcsecond jet of 3C 3435, with telescopes, B, G, Jn, Km, N, O, R, So, Wn and Yn.
B-63V	Bartel, N. (CFA)	Observations at 18 cm of SN 1979c, with telescopes B, G, O, and Yn.
B-64V	van Breugel, W. (Calif., Berkeley) Fanti, C. (Bologna) Fanti, R. (Bologna) Parma, C. (Bologna) Schilizzi, R. (NFRA)	Observations at 18 cm of three compact steep spectrum quasars, with telescopes G, H, I, Km, O, and Yn.
G-42V	Geldzahler, B. (NRL)	Observations at 18 cm of the lobe confinement in Sco X-1, with telescopes G, F, O, and Yn.
H-2V	Hough, D. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech) Perley, R.	Observations at 2.8 cm of cores of sources that are candidates for superluminal motion, with telescopes B, G, H, K, and O.
H-17V	Hooimeyer, J. (Leiden) Miley, G. (STScI) Schilizzi, R. (NFRA) van der Hulst, J. (NFRA)	Observations at 6 cm to study the compact structure in LINER galaxies, with telescopes B, G, Lm, O, So, and Yn.
J-38V	Jones, D. (JPL) Preston, R. (JPL) Readhead, A. (Caltech) Unwin, S. (Caltech)	Second epoch observations at 18 cm of of NGC 6251, with telescopes B, F, G, Jm, Km, N, O, S, Wn, and Yn.
L-36V	Linfield, R. (JPL)	Observations at 18 cm of the jet in 3C 111, with telescopes B, F, G, H, I, Jb, Km, N, O, So, and Yn.
L-37V	Lind, K. (Caltech)	Observations at 6 cm of the jet in 3C 371, with telescopes B, G, I, Jb, Km, Lb, O, and So.
M-56V	Mutel, R. (Iowa) Hodges, M. (Caltech)	Observations at 2.8 cm to monitor the outbrusts of BL Lac, with telescopes B, F, G, H, Km, and O.

No.	Observer(s)	Program
M-62V	Mutel, R. (Iowa) Lestrade, J. (JPL) Preston, R. (JPL)	Observations at 6 cm to study RS-CVn binaries, with telescopes B, G, Km, O, and Yn.
P-62V	Pilbratt, G. (Chalmers) Booth, R. (Onsala) Nicolson, G. (Hartebeesthoek) Porcas, R. (MPIR, Bonn)	Observations at 6 cm of structural variations in 3C 279, with telescopes B, G, Jb, Km, Lm, O, So, T, Wn, and Yn.
P-64V	Pedlar, A. (Jodrell) Alef, W. (MPIR, Bonn) Preuss, E. (MPIR, Bonn)	Observations at 6 cm of the nucleus of NGC 4151, with telescopes B, G, Lb, Jb, So, Wn, and Yn.
P-66V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. (MPIR, Bonn) Kellermann, K.	Observations at 2.8 cm of 3C 454.3, with telescopes B, F, G, H, and O.
R-36V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Gabuzda, D. (Brandeis) Rogers, A. (Haystack) Wardle, J. (Brandeis)	Monitoring of the milliarcsecond polarization structure of the superluminal sources 3C 120, 3C 273, 3C 345, and BL Lac at 6 cm, with telescopes B, F, G, Km, O, and Yn.
S-42V	Simon, R. (NRL)	Polarization mapping at 18 cm of 3C 138, with telescopes B, F, G, Km, O, and Yn.
S-47V	Spencer, J. (NRL) Eckart, A. (MPIR, Bonn) Hirabayashi, H. (Tokyo) Inoue, M. (Tokyo) Johnston, K. (NRL) Simon, R. (NRL) Waak, J. (NRL) Witzel, A. (MPIR, Bonn)	Observations at 6 cm of 3C 395 to determine whether it might be a superluminal resupply of a radio lobe, with telescopes B, F, G, H, I, Km, N, O, and Yn.
W-23V	Walker, R. C. Unwin, S. (Caltech) Benson, J. Seielstad, G.	Observations at 6 cm of 3C 120, with telescopes A, B, F, G, H, I, Km, N, O, So, and Yn.
W-34V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Fricke, K. (MPIR, Bonn) Johnston, K. (NRL) Schalinski, C. (MPIR, Bonn)	Third epoch observations at 6 cm of two superluminal sources from the S5 survey, with telescopes G, Jb, Km, Lm, O, So, and Wn.

No.	Observer(s)	Program
W-38V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL)	Observations at 6 cm of a complete sample of extragalactic radio sources, with telescopes B, G, Jb, Km, Lm, N, O, So, Wn, and Yn.
X-32V	Mutel, R. (Iowa) Spangler, S. (Iowa)	Observations of high dynamic range at at 18 cm of the interstellar scattering of 2013+370, with telescopes F, G, I, Km, O, and Yn.
X-33V	Langston, G. (MIT)	Observations at 6 cm of three sources selected from the MIT-Green Bank survey that are gravitational lens candidates, with telescopes F, G, Km, O, and Yn.
X-34V	Fanti, C. (Bologna) Fanti, R. (Bologna)	Observations at 6 cm of 3C 318 with G and telescopes of the European Very Long Baseline Network.
Z-9V	Zensus, A. (MPIR, Bonn) Porcas, R. (MPIR, Bonn)	Second epoch mapping at 2.8 cm of weak cores in quasars, with telescopes B, G, Km, and O.
Z-10V	Zensus, A. (MPIR, Bonn) Baath, L. (Onsala) Cohen, M. (Caltech) Lind, K. (Caltech) Unwin, S. (Caltech)	Observations at 6 cm of 3C 273 and 3C 345, with telescopes A, B, F, G, H, I, Jb, Km, Lm, N, O, So, Wn, and Yn.

C. 300-Ft OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-59	Aller, H. (Michigan) Aller, M. (Michigan) Fanti, R. (Bologna) Ficarra, A. (Bologna) Mantovani, F. (Bologna) Padrielli, L. (Bologna)	Observations at 1400 and 2695 MHz of low frequency variable sources selected from the Bologna-Michigan Program.
B-412	Burke, B. (MIT) Hewitt, J. (MIT) Langston, G. (MIT) Mahoney, J. (MIT)	Observations at 6 cm to continue the MIT-Green Bank survey at $\delta = 20° < \delta < 54°$.

No.	Observer(s)	Program
H-198	Heeschen, D. Kaftan-Kassim, M. (Unaffiliated) Lehto, H. (Virginia)	Observations at 9 cm to study the varability of extragalactic radio sources.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-409	Baan, W. (NAIC) Haschick, A. (Haystack) Schelmz, J. (Penn State)	Observations at 18 cm of OH absorption and anomalous emission in galaxies with strong continuum sources.
R-214	Richter, O. (STSI) Huchtmeier, W. (MPIR, Bonn) Materne, J. (Tech. U. Berlin)	Observations of the OH spectra of galaxies lying between Virgo and the the Hydra/Centaurus supercluster.
T-180	Turner, B. Ziurys, L. (Massachusetts)	Observations at 702 and 725 MHz for the $\Pi = 3/2, J=3/2$ multiplet of CH.
T-195	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations of HI to obtain precision redshifts for about 400 galaxies.

The following pulsar program was conducted during this quarter.

No.	Observer(s)	Program
T-178	Taylor, J. (Princeton) Dewey, R. (Cornell) Stokes, G. (Princeton) Weisberg, J. (Princeton)	Continuation of the northern hemisphere pulsar survey at 390 MHz.

D. 12-METER OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-74	Avery, L. (Herzberg) White, G. (Queen Mary College)	CO (J=2-1) observations of high velocity outflows.
B-420	Blitz, L. (Maryland) Magnani, L. (Maryland)	Study of cores of high-latitude molecular clouds.
C-224	Clark, F. Miller, J. S. (Kentucky)	Study of high-velocity CO.

No.	Observer(s)	Program
D-133	Dent, W. (Massachusetts) Balonek, T. (Williams College) Hobbs, R. (CTA)	Evolution of extragalactic radio sources at millimeter wavelengths.
G-276	Gordon, M. Jewell, P. Salter, C.	A study of dust emission from Orion A and other HII regions.
G-277	Gee, G. (Queen Mary College) Schwartz, P. (NRL)	CO and $C_{18}O$ = J=2-1 observations of globules.
G-278	Gordon, M.	Study of millimeter-wave recombination lines from galactic HII regions.
H-190	Hollis, J. M. (NASA/GSFC) Rhodes, P.	Search for additional lines of NaOH.
H-197	Ho, P. (CFA) Turner, J. (CFA) Martin, R. (IRAM, France)	2-1 CO study of three nearby spiral galaxies.
H-204	Heckman, T. (Maryland) Blitz, L. (Maryland) Wilson, A. (Maryland) Miley, G. (Johns Hopkins)	A survey of CO emission in bright, nearby Seyfert Galaxies.
I-4	Israel, F. (Leiden) Burton, W. B. (Leiden)	CO observations of dwarf galaxies.
L-192	Lewtas, J. (Cambridge) Lasenby, A. (Cambridge)	1 mm observations of SO_2 and CH_3CN in Sgr B2.
M-214	Margulis, M. (Arizona) Lada, C. (Arizona)	Study of CO in the M31 association of A22.
M-215	Moran, J. (CFA) Reid, M. (CFA) Myers, P. (CFA)	Measurement of millimeter flux from Vega.
M-216	Margulis, M. (Arizona) Lada, C. (Arizona)	Study of the density structure in the Rho-Ophiuchus dark cloud.
M-217	Martin, R. (IRAM, France) Ho, P. (CFA)	Search for thermal emission from dust globules.
M-233	Mirabel, I. (Puerto Rico) Sanders, D. (Massachusetts)	Study of CO (2-1) in galaxies with strong radio continuum fluxes.

No.	Observer(s)	Program
P-129	Payne, J. Salter, C. Shaklan, S. (Arizona) Stobie, E.	90 and 230 GHz observations of Cas A and Tau A.
R-213	Rickard, L. (NRL) Kumar, C. (Howard)	Search for CO emission from early-type galaxies.
R-218	Rodriguez, L. (Mexico) Canto, J. (Mexico) Torrelles, J. (Mexico) Ho, P. (CFA) Moran, J. (CFA)	High angular resolution CO mapping of selected outflows in regions of star formation.
R-221	Rickard, L. (Howard) Blitz, L. (Maryland)	Study of the apparent variations in CO isotope ratios within galaxies.
S-277	Salter, C. Kerr, F. (Maryland)	90 and 230 GHz observations of the galactic center.
S-278	Sanders, D. (Caltech) Scoville, N. (Caltech) Soifer, B. (Caltech)	Study of CO observations of bright IRAS galaxies.
S-282	Salter, C. Saikia, D. (Tata)	Three millimeter observations of 3C 2: a double-lobed quasar with a steep-spectrum core.
T-185	Thronson, H. (Wyoming)	Study of advanced stellar evolution and millimeter-wave emission.
T-193	Thronson, H. (Wyoming)	Study of the rest of the W3 molecular cloud.
W-172	Wright, E. (UCLA) Myers, P. (CFA)	Study of 1, 2, and 3 mm flux densities of dark clouds.
W-187	Wootten, H. A. Greason, M. (Virginia)	Study of chemical ancestry of DCN and HCN in molecular clouds.
W-190	Wolf, G. (Arizona) Lada, C. (Arizona)	Study of dense structures in high velocity molecular outflows.
W-195	Wannier, P. (Caltech) Sahai, R. (Caltech)	Study of mass-loss from M-type giant supergiant stars.

No.	Observer(s)	Program
W-196	Wilking, B. (Missouri) Lada, C. (Arizona)	Study of $C^{18}O$ column densities in the R Corona Austrinia and Rho Ophiuchi dark cloud.

E. VLA OBSERVING PROGRAMS

No.	Observer(s)	Program
AA-38	Axon, D. (Jodrell Bank) Unger, S. (Jodrell Bank) Pedlar, A. (Jodrell Bank)	The double radio source in the Seyfert galaxy NGC 5252. 6 and 20 cm.
AA-40	Abbott, D. (Colorado) Bieging, J. (Calif., Berkeley) Churchwell, E. (Wisconsin)	Nonthermal emission from OB stars. 6 cm.
AA-43	Antonucci, A.	Search for the halo around 3C 446. 20 cm.
AA-44	Antonucci, A.	The radio halo of BL Lacertae. 20 cm.
AA-45	Antonucci, R. Perley, R. Ritter, B. (NMIMT)	Definitive mapping of 3C 273. 20 cm.
AA-46	Antonucci, A. Olszewski, E. (Steward Obs.)	IRAS extreme infrared galaxies. 6 and 20 cm.
AA-47	Abbott, D. (Colorado) Bieging, J. (Calif., Berkeley) Churchwell, E. (Wisconsin)	Stellar wind emission from OB and Wolf Rayet stars. 2 and 6 cm.
AB-129	Burke, B. (Caltech/MIT) Hewitt, J. (MIT) Roberts, D. (Brandeis)	Monitoring double quasar 0957+561. 6 cm.
AB-167	Bignell, R. C. Seaquist, E. (Toronto)	Monitoring the SNR in the galaxy NGC 4449 6 and 20 cm.
AB-182	Burns, J. (New Mexico) Balonek, T. (Williams College) Hummel, E. (MPIR, Bonn)	Monitoring the cores of extended radio sources and spiral galaxies. 2, 6 and 21 cm.
AB-306	Basart, J. (Iowa State) Burns, J. (New Mexico) DeYoung, D. (NOAO)	Jets in classical doubles. 6 cm.

No.	Observer(s)	Program
AB-310	Browne, I. (Jodrell Bank) Murphy, D. (Jodrell Bank) Perley, R.	Extended structure around core-dominated quasars. 20 cm.
AB-311	Burns, J. (New Mexico) Eilek, J. (NMIMT) Christiansen, W. (N. Carolina)	A quantitative investigation of turbulence in the radio galaxy 0816+526. 2 cm.
AB-314	Baldwin, J. (Mullard Obs.) Cordey, R. (Mullard Obs.)	A search for core and jets in IC 2476. 6 cm.
AB-316	Brown, A. (Colorado) Mundt, R. (MPIA, Munich) Drake, S. (Colorado) Simon, T. (Hawaii)	HL Tau, XZ Tau, FS Tau, and related structures. 2, 6 and 18 cm.
AB-324	Blaha, C. (Minnesota) Pedelty, J. (Minnesota) Dickey, J. (Minnesota) Kennicutt, R. (Minnesota)	"Hot spot" nuclei. 6 cm.
AB-325	Bieging, J. (Calif., Berkeley) Cohen, M. (NASA/Ames)	Flux density and spectral index monitoring of V410 Tau. 2 and 6 cm.
AB-328	Bieging, J. (Calif., Berkeley) Cohen, M. (NASA/Ames)	Jets in T Tauri stars. 2 and 6 cm.
AB-331	Barthel, P. (Caltech)	Asymmetric quasars with steep spectrum radio cores. 6 cm.
AB-333	Becker, R. (Calif., Davis) Helfand, D. (Columbia)	Galactic supernova remnants. 20 cm.
AB-335	Brown, R.	Radio recombination lines toward 0235+164. 21 cm line.
AB-336	Bieging, J. (Calif., Berkeley) Goss, W. M. (Groningen)	HI absorption in Cas A. 21 cm line.
AB-337	Brinks, E. (ESO, FRG) Klein, U. (Bonn) Dettmar, R. (MPIR, Bonn)	HI observations of blue compact dwarf galaxies. 21 cm line.
AC-104	Cornwell. T. van Breugel, W. (Calif., Berkeley) Ekers, R. Smarr, L. (Illinois)	The db system NGC 4782/NGC 4783. 6 and 20 cm.

No.	Observer(s)	Program
AC-110	Campbell, B. (Mt. Wilson)	Continuum sources in regions of high velocity molecular gas. 1.3, 2 and 6 cm.
AC-117	Coleman, P. (Pittsburgh) Condon, J. Mitchell, K. (VPI & SU)	Angular-size distribution of faint sources. 20 cm.
AC-121	Crane, P. Price, R. (New Mexico)	The radio nucleus of M81. 2 cm.
AC-128	Cameron, R. (Mt. Stromlo) Bicknell, G. (Mt. Stromlo) Ekers, R.	Jet radio sources in southern clusters. 6, 18 and 20 cm.
AC-131	Comins, N. (Maine) Hayes, J. (Maine)	3C 442. 6 and 20 cm.
AC-132	Cecil, G. (Hawaii)	Four active galaxies with spatially-extended forbidden-line regions. 6 cm.
AC-134	Claussen, M. (Massachusetts) Sahai, R. (Texas)	Carbon star IRC+10216. 2 cm.
AC-135	Cameron, R. (Mt. Stromlo) Parma, P. (Bologna) de Ruiter, H. (Bologna)	A statistical study of the structure of dumbbell galaxy radio sources. 20 cm.
AC-136	Cameron, R. (Mt. Stromlo) Bicknell, G. (Mt. Stromlo) Ekers, R.	HI observations of NGC 7017, for modelling of a jet radio source. 20 cm line.
AD-61	Dressel, L. (Rice)	High frequency spectrum of UGC 09114. 1.3, 2, and 6 cm.
AD-129	Dreher, J. (MIT) Johnston, K. (NRL) Welch, W. J. (Calif., Berkeley)	W 49. 6 cm.
AD-140	Downes, A. (Cambridge) Gull, S. (Cambridge) Tan, S. (Cambridge)	First epoch observations of the young SNR G11.2-0.3. 6 and 20 cm.
AD-142	Dickel, J. (Illinois) Long, K. (Johns Hopkins) Matsui, Y. (Johns Hopkins) Greisen, E.	Second epoch observations of Kepler's SNR. 6 and 20 cm.

No.	Observer(s)	Program
AD-145	Duric, N. (Toronto) Seaquist, E. (Toronto) Crane, P. Davis, L. (NOAO)	Spiral galaxy NGC 4736. 6 and 20 cm.
AD-153	Dickel, H. (Illinois) Goss, W. M. (Groningen) Rots, A.	Recombination line observations of NGC 7538 IRS 1. 2 cm line.
AD-159	Dickey, J. (Minnesota) Brinks, E. (ESO, FRG)	HI absorption through the disk of M31. 21 cm line.
AD-160	de Pater, I. (Calif., Berkeley)	Jupiter Patrol. 6 and 20 cm.
AD-161	Drake, S. (Colorado) Linsky, J. (Colorado) Simon, T. (Hawaii)	Short period RS CVn binaries. 6 cm.
AD-162	Doiron, D. (Clemson) Genet, R. (Fairborn)	Radio survey of suspected radio binary stars. 2, 6 and 18 cm.
AE-28	Escalante, V. (CFA) Ho, P. (CFA) Haschick. A. (Haystack) Rodriguez, L. (Mexico)	Accurate positions of H_2O masers associated with young objects. 1.3 cm line.
AF-63	Faber, S. (Calif., Santa Cruz) Raimond, E. (NFRA) Knapp, G. (Princeton) Gallagher, J. (Illinois) van Gorkom, J.	HI distribution in the elliptical galaxy NGC 1052: high velocity absorption. 21 cm line.
AF-74	Feretti, L. (Bologna) Giovannini, G. (Bologna) Gregorini, L. (Bologna)	New, wide-angle tail galaxy in A115. 20 cm.
AF-102	Fich, M. (Washington) Taylor, A. (Leiden)	A complete survey in the Galactic Plane. 6 and 20 cm.
AF-106	Fanti, C. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Low luminosity, B2 radio galaxies. 20 cm.
AG-116	Gibson, D. (NMIMT) Priedhorsky, W. (Los Alamos)	Search for 300-day periodicity in Cyg X-1. 2, 6 and 20 cm.

No.	Observer(s)	Program
AG-163	Goss, W. M. (Groningen) Ekers, R. Sramek, R. Branch, D. (Oklahoma) Cowan, J. (Oklahoma)	Search for very young supernova remnants in our galaxy. 6 cm.
AG-173	Gower, A. (Victoria) Hutchings, J. (DAO) Condon, J.	Disk continuum emission from spiral galaxies with quasars. 20 cm.
AG-176	Garay, G. (ESO, FRG) Moran, J. (CFA) Reid, M. (CFA) Rodriguez, L. (Mexico)	Continuum emission associated with hot ammonia peaks. 1.3, 2 and 6 cm.
AG-177	Garay, G. (ESO, FRG) Moran, J. (CFA) Reid, M. (CFA) Rodriguez, L. (Mexico)	Variability of Theta Orionis. 2, 6 and 20 cm.
AG-178	Garay, G. (ESO, FRG) Reid, M. (CFA) Moran, J. (CFA)	Search for compact radio sources in the Lagoon and Triffid nebulae. 6 cm.
AG-180	Gardner, F. (CSIRO) Whiteoak, J. (CSIRO)	HI and OH in the galaxy NGC 5793. 21 cm line.
AG-181	Giovannini, G. (Bologna) Feretti, L. (Bologna)	NGC 4869. 6 cm.
AG-182	Garcia-Barreto, J. (Mexico) Pismis, P. (Mexico)	Nuclear emission form the barred galaxy NGC 4314. 6 and 20 cm.
AG-183	Gilmore, G. (Cambridge) Gregorini, L. (Bologna) Padrielli, L. (Bologna) Parma, P. (Bologna)	A complete sample of radio galaxies of intermediate strength. 20 cm.
AG-184	Green, D. (Cambridge) Gull, S. (Cambridge)	New young SNRs. 6 and 20 cm.
AG-185	Gottesman, S. (Florida) England, M. (Florida) Hunter, J. (Florida) Huntley, J. (Bell Labs)	HI observations of the barred spiral galaxy NGC 1300. 21 cm line.

No.	Observer(s)	Program
AG-186	Gorenstein, M. (CFA) Perley, R. Huchra, J. (CFA)	Detection of gravitational lens 2237+03. 20 cm.
AG-187	Garwood, R. (Minnesota) Dickey, J. (Minnesota)	Galactic 21 cm absorption survey at low latitudes near the Galactic Center. 21 cm line.
AG-188	Grindlay, J. (CFA) Garcia, M. (CFA) Seaquist, E. (Toronto)	Spectra and variability study of GX13+1. 6 and 20 cm.
AG-189	Glendenning, B. (Toronto) Kronberg, P. (Toronto)	The peculiar spiral NGC 2146. 2, 6 and 20 cm line.
AH-164	Hintzen, P. (Goddard) Owen, F.	Physically large QSO radio sources. 6 cm.
AH-173	Hogg, D.	Radio emission from two emission-line galaxies. 2, 6 and 20 cm.
AH-180	Hanisch, R. (STScI) Burns, J. (New Mexico)	Compact radio sources associated with interacting galaxies in poor clusters 2 and 6 cm.
AH-187	Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Gusten, R. (MPIR, Bonn) Johnston, K. (NRL)	Water masers in the galaxy M82. 1.3 cm line.
AH-188	Hughes, V. (Queens) McLean, B. (STScI)	W UMa stars. 6 and 20 cm.
AH-190	Harris, D. (CFA) McHardy, I. (Leicester) Dewdney, P. (DAO)	Morphologies of steep spectrum radio sources in X-ray emitting clusters of galaxies. 6 and 20 cm.
AH-191	Ho, P. (Harvard) Lo, K. (Caltech)	Linear continuum structures in the Galactic Plane. 20 cm.
AH-195	Hjellming, R. Davis, R. (Jodrell Bank)	Nova RS Ophiuchi. 1.3, 2, 6 and 20 cm.
AH-203	Hjellming, R. van Gorkom, J.	HI shell around RS Oph. 21 cm line.
AI-21	Israel, F. (Leiden) Skillman, E. (NFRA)	NGC 2403. 20 cm.

No.	Observer(s)	Program
AI-22	Israel, F. (Leiden) Skillman, E. (NFRA)	NGC 6822, IC 1613 and Leo I. 6 cm.
AJ-115	Jackson, J. (MIT) Barrett, A. (MIT) Ho, P. (Harvard)	Continuum survey of starburst galaxies detected in CO. 2 cm.
AJ-124	Jorsater, S. (ESO, FRG.) Bergvall, N. (Uppsala Ast. Obs.)	The blue compact galaxies ESO 350-IG38 and ESO 400-G43. 6 and 20 cm line.
AK-119	Kailey, W. (Arizona) Elston, R. (Arizona)	Search for supernova remnants near the nucleus of M33. 6 cm.
AK-127	Karoji, H. (I. of Ast., Paris) Dennefeld, M. (I. of Ast., Paris) Merat, P. (I. of Ast., Paris) Ukita, N. (Nobeyama Obs.)	High reddening galaxies in the IRAS Catalogue. 20 cm.
AL-94	Liszt, H. Burton, W. B. (Leiden)	Structure of Sgr C. 20 cm.
AL-95	Lane, A. Reynolds, S. White, N. (ESTEC, NETH)	Flares from RS CVn stars and Algol. 2 and 6 cm.
AL-97	Lang, K. (Tufts) Willson, R. (Tufts)	M dwarf flare stars and RSCVn stars. 2, 6 and 20 cm.
AL-99	Lang, K. (Tufts) Willson, R. (Tufts)	Coordinated VLA and Solar Maximum Mission observations of solar maser emission and cyclotron line emission. 20 cm.
AM-124	McHardy, I. (Leicester) Warwick, R. (Leicester) Smith, A. (ESTEC, NETH)	Coordinated radio, optical and X-ray observations of OVVs and BL Lac objects. 2, 6 and 20 cm.
AM-135	Mutel, R. (Iowa) Lestrade, J. (Bur. d'Long.,Paris)	Radio activity in RS CVn binaries - correlation with period. 2, 6 and 20 cm.
AM-147	Masson, C. (Caltech)	Expansion motions in CGC 7027. 2 and 6 cm.
AM-150	Muhleman, D. (Caltech) Berge, G. (Caltech) Linfield, R. (JPL)	Astrometric observations of Uranus. 1.3 and 2 cm.

No.	Observer(s)	Program
AN-30	Neff, S. (NAS/NRC at NRL)	Search for short-term variability in 2 Seyfert galaxies. 1.3, 2, 6 and 20 cm.
AO-49	Owen, F. O'Dea, C. Burns, J. (New Mexico) Smarr, L. (Illinois)	Wide angle tail sources. 6 cm.
AO-60	Odenwald, S. (NRL) Schwartz, P. (NRL)	Compact IR sources in DR 20. 6 and 20 cm.
AO-61	Oznovich I. (NMIMT) Gibson, D. (NMIMT)	Magnetic activity in five late-type giants and supergiants. 20 cm.
AP-90	Parma, P. (Bologna) Fanti, R. (Bologna) Lari, C. (Bologna) Fomalont, E. Ekers, R.	NGC 326. 6 cm.
AP-94	Parma, P. (Bologna) de Ruiter, H. (Bologna) Fanti, C. (Bologna) Fanti, R. (Bologna) Ekers, R.	B2 0755+37. 6 cm.
AP-97	Pedelty, J. (Minnesota) Rudnick, L. (Minnesota)	Relic pre-hotspot emission in 3C 295? 6 cm.
AP-98	Pettengill, G. (MIT) Chapman, B. (MIT)	Radio emissivity of the surface of Mercury. 2 and 6 cm.
AP-100	Payne, H. Terzian, Y. (Cornell)	OH line observations of planetary nebulae. 21 cm line.
AP-102	Peacock, A. (ESTEC, NETH) Smith, A. (ESTEC, NETH)	SNR G127.1+0.5. 2, 6 and 20 cm.
AR-116	Rusk, R. (Toronto) Seaquist, E. (Toronto) Yen, A. (Toronto)	Brightness and polarization structure of sources with published VLBI structural position angles. 2, 6 and 18 cm.
AR-122	Rudnick, L. (Minnesota) Dickey, J. (Minnesota) Benford, G. (Calif., Irvine)	Search for coherent radiation from non-thermal sources. 6 and 20 cm.

No.	Observer(s)	Program
AR-123	Rudnick, L. (Minnesota) Pedelty, J. (Minnesota) Spinrad, H. (Calif., Berkeley)	Extended emission line systems in distant galaxies. 6 cm.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NSF)	Monitoring supernovae SN1980 in NGC 6946 and SN1979c in M100. 6 and 20 cm.
AS-206	Snell, R. (Massachusetts) Bally, J. (Bell Labs) Schwartz, P. (NRL)	Radio jets associated with L1551 IRS-5. 2 and 6 cm.
AS-211	Sramek, R. Weiler, K. (NSF) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Monitoring statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-217	Schmahl, E. (Maryland) Kundu, M. (Maryland) Shevgaonkar, R. (Maryland)	Hot and cold components of solar prominences. 2, 6 and 20 cm.
AS-218	Shone, D. (Jodrell Bank) Browne, I. (Jodrell Bank) Walsh, D. (Jodrell Bank) Rudnick, L. (Minnesota) Pedelty, J. (Minnesota)	The remarkable jet in 0800+608. 2 and 6 cm.
AS-221	Schaefer, B. (Goddard) Cline, T. (Goddard) Laros, J. (Los Alamos)	High precision gamma-ray burst source fields. 6 and 20 cm.
AS-222	Savage, A. (Edinburgh) Smith, M. (Edinburgh) Condon, J.	Surveys of QSO fields. 20 cm.
AS-223	Seaquist, E. (Toronto) Bode, M. (Jodrell Bank)	Compact structures in the nova remnant GK Per. 6 and 20 cm.
AS-224	Smith, A. (ESTEC, NETH) Peacock, A. (ESTEC, NETH)	SNR W49B. 20 cm.
AS-225	Smith, R. (Sussex)	Southern radio galaxies: 0625-35. 6 and 20 cm.
AS-226	Sumi, D. (Illinois) Smarr, L. (Illinois) Owen F.	The cD galaxy in Abell 2029. 6 and 20 cm.

No.	Observer(s)	Program
AS-228	Seaquist, E. (Toronto) Taylor, A. (Groningen)	Radio survey of symbiotic stars, III. 2 and 6 cm.
AS-229	Schechter, P. (Mt. Wilson) van Gorkom, J. Steiman-Cameron, T. (Mt. Wilson)	HI in SO galaxies with polar rings. 21 cm. line.
AS-230	Sramek, R. Skillman, E. (NFRA)	The SNR in NGC 5471. 2 cm.
AT-57	Taylor, A. (Groningen) Leahy, D. (Calgary) Seaquist, E. (Toronto)	Circumstellar HI absorption in slow novae: Hm Sge. 21 cm line.
AT-58	Tuffs, R. (MPIR, Bonn) Angerhofer, P. (USNO) Brown, M. (Cambridge) Gull, S. (Cambridge) Perley, R.	Structure and secular change within Cassiopeia A. 6 cm.
AT-59	Turner, K. (Arecibo)	24 detected radio stars. 6 and 20 cm.
AT-60	Taylor, A. (Groningen) Seaquist, E. (Toronto) Kenyon, S. (CFA)	Radio-optical-UV monitoring of symbiotic stars. 1.3, 2, 6 and 20 cm.
AT-61	Taylor, A. (Groningen) Seaquist, E. (Toronto)	A rotating(?) "jet" from the symbiotic star SS96. 2 cm.
AT-62	Taylor, A. (Groningen)	New stellar radio sources. 6 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NSF)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-119	van Breugel, W. (Calif.,Berkeley) Heckman, T. (Maryland) Miley, G. (STScI/Leiden)	Radio and optical shells in PKS 0634-206. 20 cm.
AV-120	Viallefond, F. (Meudon) Comte, G. (Marseille Obs.) Lequeux, J. (Marseille Obs.) Kunth, D. (Inst. of Ast., Paris) Vigroux, L. (CEA Saclay)	HI and continuum observations of blue compact galaxies. 6 and 20 cm line.
AV-121	Viallefond, F. (Meudon) Comte, G. (Marseille Obs.) Lequeux, J. (Marseille Obs.)	HI observations of the dwarf irregular galaxy SDIG. 21 cm line.

No.	Observer(s)	Program
AW-95	Winnberg, A. (Onsala) Baud, B. (Groningen) Habing, H. (Leiden) Olnon, F. (Leiden) Matthews, H. (Herzberg Inst.)	Survey for OH/IR stars close to the Galactic Center. 18 cm line.
AW-122	Wehrle, A. (Calif, Los Angeles) Morris, M. (Calif, Los Angeles)	Vertical radio structure in the nuclei of normal spiral galaxies. 6 cm.
AW-125	Willner, S. (CFA) Turner, J. (CFA) Ho, P. (CFA)	Survey of spiral galaxy nuclei. 6 cm.
AW-126	Wilson, A. (Hawaii/Maryland) Ulvestad, J. (JPL)	A distance limited sample of Seyfert galaxies. 6 and 20 cm.
AW-132	Wehrle, A. (Calif., Los Angeles) Ekers, R.	Nuclear region of NGC 4631. 2 cm.
AW-134	Wilson, A. (Hawaii/Maryland) Ward, M. (Cambridge)	Relation between optical line and radio continuum emissions in two Seyfert galaxies. 6 and 20 cm.
AW-135	Wills, D. (Texas) Wills, B. (Texas)	Close pairs of QSOs. 6 cm.
AW-136	Wall, J. (Royal Greenwich Obs.) Sansom, A. (Sussex) Sparks, W. (Sussex) Disney, M. (Cardiff, Wales) Terlevich, R. (Royal Greenwich Obs.) Laing, R. (Royal Greenwich Obs.) Jenkins, C. (Royal Greenwich Obs.)	Survey of bright elliptical galaxies. 6 cm.
AY-8	Yusef-Zadeh, F. (Columbia) Morris, M. (Calif., Los Angeles)	Completion of a long-term study of the Galactic Center "Arc." 2, 6 and 20 cm.
AZ-25	Zukowski, E. (Toronto) Kronberg, P. (Toronto)	Strong extended radio sources which exhibit peculiar integrated polarization curves. 18 and 22 cm.
VAH-34	Mutel, R. (Iowa) Spangler, S. (Iowa)	2013+370: The scattering size. 18 cm.
VAH-35	Langston, G. (MIT)	Search for gravitational lenses. 6 cm.

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F. SCIENTIFIC HIGHLIGHTS

New Extragalactic Megamaser

The galaxy U8696 was recently found to contain a powerful OH megamaser at a velocity of 11 k/s with respect to the HI absorption systemic velocity. This brings to four the total number of galaxies known with OH megamasers. With the exception of IC 4553, discovered at Arecibo, the megamaser galaxies have been detected as part of an extensive 300-ft survey of galaxies and strong nuclear continuum sources. The megamasers seem to require both the presence of infrared pumping radiation to produce the strong maser inversions in the molecular gas and sufficient nuclear source radio continuum radiation to be amplified. Additional examples of these galaxies can provide valuable insight into the nature of these active galactic nuclei.

HI Minimum Column Density

The 140-ft telescope was used to make a detailed 21 cm study of the area that has the smallest known amount of HI in the northern sky. Located at $10^h\ 45^m$, +47° in Ursa Majoris, the 4°x3° field shows a mean N_{HI} of $\sim 6 \times 10^{19}$ cm^{-2} and a minimum value of 4.5×10^{19} cm^{-2}. Implications of these minimum values are that the galactic HI layer is opaque to extragalactic radiation between 13.6 eV and 100 eV. The available spectral information in this and other low HI directions suggests that there is a ubiquitous population of small HI clouds (typical $N_{HI} \sim 2 \times 10^{19}$ cm^{-2}) that are detectable in half the lines of sight. These clouds are simply too faint to be seen in directions where HI is bright. Use of the extremely sensitive 140-ft system was critical to the success of the experiment. Also important was confidence in the stray radiation subtraction procedure in low HI directions where stray radiation dominates the observed signal.

HII Region Continuum Maps at 3 mm

Several extended HII regions, including Orion A, have been mapped in the 3-mm continuum with the 12-m telescope. Recent changes in the telescope drive program have significantly reduced uncertainties in the telescope pointing to the extent that postprocessing algorithms can now successfully deconvolve the output of the beam-switching observing technique. Prior to this time such continuum maps were only available at centimeter wavelengths where the pointing uncertainties were less crucial. The eventual production of 1-mm continuum maps will help separate out the contribution to the composite source spectra of thermal dust emission and free-free emission from the ionized gas.

Jet from CH Cyg

VLA Monitoring observations of a sample of symbiotic stars have uncovered an expanding jet from the star CH Cyg. As seen on a high resolution, 2-cm A array map, the outburst is identifiable as a co-linear triple source with total extent of 0.4 arcsec, which was not visible prior to November, 1984. For a distance of 600 pc, the expansion velocity of the two-sided jet has been calculated as ± 1500 k/s, indicating that the initial impulsive event occurred between July and September, 1984. Over the past year the 2-cm flux densities have increased from 1.4 to 40 mJy. In addition to

the dramatic evidence for a radio jet, there is independent optical evidence for the existence of an accretion disk in the CH Cyg system.

Second Type I Supernova Detected

Prior to 1983 only Type II supernovae had been detected in the radio. The first Type I SN to be detected at the VLA, SN 1983.51, was characterized by the steep rate of decline of its radio light curve (a few months detection span only). Continued monitoring with the VLA of all supernovae to exceed a visual magnitude of 14 has recently resulted in the detection of a second Type I supernova, SN 1984ℓ in NGC 991. Aside from their radio emission, the two Type I supernovae are distinguishable from other nonradio detected Type I's by means of optical spectral peculiarities. At optical maximum their spectra are more closely akin to normal Type I's which have decayed much further along their light curve and there is a notable absence of typical iron features in their spectra. The radio properties of these supernovae will aid in the determination of mass loss rates in the later stages of stellar evolution, and on the physical characteristics of the progenitor stellar system.

Extended HI in M51

HI maps of the grand design spiral M51 have been made from VLA data which significantly improve available information about the morphology and kinematics of the galaxy's extended HI features. Although the resolution of the observations do not allow a detailed study of the inner spiral structure of M51, the sensitive VLA data gives a much better look at the distribution of gas at anomalous velocities in the galaxy's outer extremities where evidence of interaction with the companion, NGC 5195, is seen. Modelling the tidal interactions of the two galaxies to accommodate the newly seen details appear to be more difficult than an earlier preliminary analysis in 1972.

G. PUBLICATIONS

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

H. GREEN BANK ELECTRONICS

300-ft Spectral Processor

A high-speed spectrometer is being designed and built, and the antique DDP 116 control computer is being replaced with a modern 68000 microprocessor-based computer by MASSCOMP. This is a two-in-one project because the DDP 116 hardware and software could not handle the high data rate and complexity put out by the new spectrometer. The spectrometer will provide 2048 total frequency points in up to two independent channels of 40 MHz maximum bandwidth for spectral-line observations. Also, it will greatly enhance pulsar searches and measurements of pulse timing, profiles, frequency spectra, and polarization. Timing resolution will be as short as 12 microsec. All

frequency spectra can be dedispersed and averaged in time or frequency. Most functions occur in hardware under control of a second MASSCOMP computer. Digital design is at the level of defining word size, addressing schemes, and operating speeds. Breadboards of input buffers and switching circuits are being tested. Low power CMOS multipliers for the FFT butterflies are being tested and may replace TTL multipliers tested earlier. Software design for the controller is at the block diagram and flow chart stage. Design and prototyping of the IF section was again temporarily suspended this quarter.

2 to 5 GHz Receiver

A very low-noise system for spectral-line observing on the 300-ft and 140-ft telescopes was developed. Like the low-noise L-band receiver, the 2-5 GHz receiver uses 2 HE mode, high-efficiency, low-spillover feeds having 10 percent bandwidth, a cooled orthomode transducer and Green Bank designed and built, cooled FET amplifiers. Presently the Band 1 receiver has two feeds covering 2.90 to 3.15 GHz and 3.15 to 3.40 GHz. Amplifiers over 2.90 and 3.50 GHz with a system temperature of 25 K measured in the test stand with the feed at the zenith. Observing on the 140-ft telescope during the quarter measured 30 K and 33 K system temperatures in channels A and B. Band 2 amplifiers, under development in Green Bank, will cover 4.60 to 5.10 GHz. Construction continues on the cooled orthomode transducer, feed, and phase-locked LO for the Band 2 receiver.

5 GHz, 7-Feed Receiver

A 7-feed receiver will provide significantly improved multibeam continuum mapping capability with the 300-ft telescope at 5 GHz. Northern sky maps down to 10 mJy and analogous to the Palomar Sky Survey (2.7-mm beam circle on the PSS scale with over 300 sources per 6° x 6° "plate") could be produced in 90 days of observing. Also, the galactic plane out to b = ± 5° could be mapped to 10 mJy rms in only one day. Successive maps would reveal variable sources. Each feed will be dual circularly polarized with cooled orthomode transducers. Each of the 14 receivers consist of a cooled FET amplifier (4.6 to 5.1 GHz, under development in Green Bank) followed by a bandpass filter, ambient FET amplifiers, and a square-law detector. Fabrication is about two-thirds complete, with internal dewar assembly, feeds, and major receiver components remaining.

I. TUCSON ELECTRONICS

70-120 GHz Schottky Mixer Receiver

This new Schottky-mixer receiver covers the 70-120 GHz band with two mixers so as to optimize the performance across the band. The high-frequency half of the receiver, 105-115 GHz, covers the fundamental rotation transitions of the ubiquitous molecular tracer CO and its isotopes. The lower half, 70-90 GHz, includes a wide range of molecular transitions from species such as HCN and HCO+; from these species we may infer the chemistry of molecular clouds as well as the thermodynamical properties of molecular matter. With this receiver on the telescope, we measure a single sideband receiver temperature of 330 K at both 90 and 115 GHz. Telescope tests have revealed some receiver problems which will be rectified during summer shutdown. Specifically,

it appears that the SSB noise temperature can be reduced by 50 K or more and that the spectral baseline stability can be improved.

SIS CO (J=1-0) Receiver

In April, a dual-channel SIS 3-mm receiver was given its initial telescope tests. The two SIS junctions differed in design and fabrication: one was a GSFC junction while the other was built in the NRAO central development laboratory. Both junctions performed satisfactorily and provided receiver temperatures less than 120 K SSB on the telescope. Over the next few months efforts will be made both to lower the receiver noise by redesigning or replacing the feed lens and to improve the disappointingly short hold-time of the 2.5 K cryostat.

Bolometer

The 0.8-2.0-mm bolometer was used successfully on the telescope in April. Installation of an improved bolometer element appears to have eliminated the microphonic problems that plagued this receiver in the past. The beam at 1.4 mm is diffraction limited and the sensitivity in good weather is 2-6 Jy/sec. The optimum sensitivity of the bolometer is likely to be achieved only during times of excellent atmospheric transparency and stability. By replacing the bolometer element with a new element having one-half the NEP of the present bolometer, it appears feasible to improve the sensitivity by a further factor of two. Tests with the new element will be conducted in the fall.

CO (J=3-2) Receiver

While observation of any one rotational transition of CO is adequate to tell the astronomer about the presence of molecular gas and the kinematics of that material. It is not adequate to provide information about the amount of gas present or about its temperature and excitation. For the latter purpose it is necessary to observe more than one rotational transition and, if possible, more than one isotopic species. The J=3-2 rotational transition of CO at 345 GHz is very desirable for such studies of the excitation of molecular clouds. This line, together with the J=2-1 line at 230 GHz and the J=1-0 line at 115 GHz, provides a very complete picture of the mass, kinematics, thermodynamics of molecular clouds.

A simple, single-channel, Schottky mixer receiver for the J=3-2 line of CO was built and tested on the telescope. This receiver was meant to allow us to evaluate the telescope performance and the atmospheric transparency above Kitt Peak at 345 GHz. We find the aperture efficiency at this frequency to be 14 percent, the main beam is gaussian, diffraction-limited, and has no sidelobes above 10 dB. In only three days of tests the zenith optical depth was never better than 0.5.

J. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At lower frequencies the increased strength of the

background sources which fill the primary beam more than offset the larger primary beam width and limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beam so the source being imaged is effected directly. For example, at 44 GHz a 20" pointing error causes a 30% change in amplitude.

When the VLA antennas are illuminated by the sun at a low elevation angle, differential temperatures of up to 5 degrees Celsius have been observed across the antenna structure. Under these conditions the pedestal and yoke of the antenna can bend significantly and cause pointing errors of up to one arcminute. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. This process will take until 1986 to complete.

Another, lesser, pointing problem which will be addressed in the future 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 presumably caused by deformations or perturbations in the azimuth bearings. This and other problems such as an antenna tilt caused by a constant wind force could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure.

Sixteen antennas now have insulation installed to improve their pointing.

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 these techniques at these low frequencies is required to better understand the type of algorithm needed. To do this, we wish to equip the current 25-m antennas with simple dipole-type feeds. If modest efficiency results (anything more than 15% will be adequate), we should be able to collect sufficient data from the 25-m antennas at this frequency for testing purposes. Note that if every 25-m antenna had such a feed, the entire 3C and 4C catalogue could be mapped at 75 MHz with the same resolution as the original 1400 MHz aperture synthesis catalogue done at Cambridge. The cost of this outfitting is very modest.

Four antennas now have 75 MHz receivers and a log-periodic antenna outrigged on the side of the 25-m reflectors. Two new dipole feeds have been designed, one a crossed dipole type, the other a quad dipole type. These are installed on two antennas and testing to start during the next quarter.

300 MHz Receiver

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

The receiver will be designed so that observations in the range 300-350 MHz can be made with an instantaneous bandwidth of approximately 5 MHz. At this low frequency, the VLA 25-m diameter antennas can only be used in prime focus mode. It is known that radio frequency interference, both locally generated at the VLA and from external sources, will be a significant problem.

Seven antennas now have 327 MHz receivers installed, and this system is undergoing test and evaluation. The final feed configuration is expected to be determined next quarter. To reduce local RFI modification to some modules has been undertaken. (See RFI IMprovements.)

JPL Mods

Feeds and front-ends covering the frequency range 8.0-8.8 GHz will be installed on the VLA primarily to allow reception of the Voyager signal from Neptune at 8415 MHz. Other scientific benefits include the provision of an additional frequency for measurements of continuous spectra, and joint observations with the VLB array. There are also some molecular lines of limited interest between 8.8 and 9.2 GHz which may be covered. Finally, the 8.4 GHz front-ends would enable the VLA to be used in planetary radar experiments with the Goldstone transmitter. The NRAO Central Development Laboratory will develop this front-end. This front-end amplifier will probably be a GaAs FET amplifier or an improved HEMT (High Electron Mobility Transistor) amplifier.

A second 8.4 GHz front-end was received from the Central Development Laboratory in Charlottesville and has been installed on Antenna 21. Interferometer measurements with Antennas 20 and 21 on both Voyager I and II have been completed with the appropriate signal to noise ratio.

JPL has provided funding for this project and antennas being overhauled will be outfitted with X-band feed towers. Installation of the next X-band system is scheduled for the second quarter in 1986.

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 will be investigated.

Three modules appear to be the present major source of RFI. One set of these modules have been modified and preliminary tests indicate good improvement. Another set of these modules will be modified so that a pair of modified antennas may be compared against a pair of unmodified antennas to determine the amount of improvement.

Water Vapor Radiometers

The development of a system to measure the total precipitable water in a path through the atmosphere will serve three purposes. First, the radiometer developed in this project can be used as a prototype of the device which is required at each VLBA station. Second, the radiometer can be used at the VLA to provide estimates of the extinction, giving corrections for observations at 1.3 cm and serving as a historical record of the quality of the VLA site. Finally, if a reliable system can be built at a sufficiently low cost, it would be attractive to add them to the VLA itself.

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

The R.F. components for the water vapor radiometers have been procured and are being assembled for testing. The project is manpower limited.

K. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

On June 1 work began on the further development and construction of thirty 8.4 GHz receivers for use on the VLA for reception of telemetry signals from the Voyager 2 spacecraft. The VLA will be used for reception of television pictures of Neptune during a brief period centered on August 24, 1989.

A schedule for construction of the front-ends has been made and shows delivery of a first unit by January 1986 and last unit by October 1987. The first three front-ends will utilize FET amplifiers, and the construction of the amplifiers has started. HEMT devices will be evaluated between September 1985 and April 1986, and a decision as to whether to use FET or HEMT devices will be made in May 1986. During June, lab space for the project was prepared and procurement of long-term delivery items has started.

HEMT Device Development

A joint NRAO/JPL, \$150k/\$200k support program of Cornell/GE for development of HEMT transistor devices giving as design goals < 10 K noise at 8 GHz and < 30 K at 23 GHz was in effect during CY 84. These noise temperatures would provide approximately a factor of 1.4 system sensitivity improvement compared to FET amplifiers and would allow observations to be performed in one-half of the telescope time. The 8 GHz design goal was met in August 1984 by a GE device which gave 8.5K at 8.4 GHz and 3.5 K at 3.3 GHz; the 23 GHz goal was not achieved. Cornell is continuing the work with other support, and GE will receive a contract extension from JPL to supply 75 HEMT devices for use in the Voyager/Neptune receivers.

During this quarter additional HEMT's were received from GE. These devices had the best room temperature performance we have measured but did not perform well at cryogenic temperatures.

Schottky-Diode Millimeter-Wave Mixer Development

Cryogenically cooled, Schottky-diode mixers have been in use for almost all millimeter-wave astronomy for the past ten years. NRAO has pioneered the development of the mixers, both in circuit design and, by contract to the University of Virginia, in the development of the diode devices. During this quarter, three 70-90 GHz mixers were completed, and work has continued on 270-290 GHz units

Superconducting Junction (SIS) Millimeter-Wave Mixer Development

The SIS mixers have theoretical noise temperatures many times lower than diode mixers and experimentally have given a factor of two improvement in sensitivity at 115 GHz. It is believed that most future astronomy between frequencies of 40 and 500 GHz will be performed with SIS mixer receivers. The development involves circuit design and testing at NRAO and SIS device fabrication by contracts with the University of Virginia and the National Bureau of Standards. Recently some all-niobium junctions (which should have higher reliability) have been fabricated by Hypres, Inc. through a Navy contract and have been made available to NRAO for testing. Several problems were found in the design and fabrication process of these junctions and will be corrected in a future batch.

Apparatus for fabrication of all-niobium junctions is also being pursued in collaboration with the University of Virginia. Design of a 230 GHz SIS mixer continues.

Planar Mixer-Antenna Development

The goal of this research is to provide the millimeter-wave equivalent of the optical photographic plate; i.e., a substrate patterned with antenna-feed elements and either SIS devices or planar Schottky-diodes forming many receivers. This "multi-beaming" would greatly advance the speed or sensitivity of millimeter-wave astronomy. At the present time the system aspects of the problem are being investigated and the radiation patterns of low frequency, planar, log-periodic antennas are being measured.

Hybrid-Spectrometer

A spectrometer, which is a hybrid of analog-filter and digital-correlator techniques, is under construction for providing 1536 channels and 2.4 GHz bandwidth on the Tucson 12-meter telescope. It is shown in NRAO Electronic Division Internal Report No. 248 that this hybrid approach gives much lower cost than an all-digital or all-analog system; this is very important for future millimeter-wave astronomy arrays.

One-eighth of the final system has been completed and will be tested in the last half of 1985.

L. VLA COMPUTER DIVISION

On-Line System

The major upgrade to the on-line system at the VLA is progressing well. The plan encompasses a complete change of the ModComp computers which control and monitor the telescope and acquire the scientific data for later reduction. The upgrade will extend over several years, with final conversion to the new system planned for 1986. The new system will allow for added capabilities in control of the telescope and additional programs for the initial calibration and editing of telescope data; these additional features are not available now because of the limited speed and memory in the existing systems. In addition, support for the NASA Voyager encounter with Neptune will be provided. The decision was made in 1984 to continue with ModComp as the vendor for the on-line computers, primarily for software compatibility reasons. Two development computers (ModComp Classic II/75's) and some peripherals were purchased in 1984, with the option of supplementing or upgrading them in 1985 when ModComp could provide 32-bit capabilities in a new line of computers. These development systems have been used for work on the software needed for controlling the VLA as is presently done.

During the second quarter of 1985, an alternative to the re-sampling of analog sum data was implemented for spectral line mode. If the array is phased, data from all baselines may be summed and only one baseline (the sum) archived. This preserves the sensitivity of the full VLA without recording all the data and is useful for observations that do not involve mapping, absorption studies, for example.

The new 32-bit computers (Classic 32/85's) were ordered from ModComp. These systems are due to be delivered to the VLA in September. Full allowance for trade-in of the Classic II/75's, bought in 1984, was applied to the new purchase. Development of the software for the new system continued.

Pipeline System

The Pipeline system of computers at the VLA is a network of several PDP-11 computers, FPS array processors and shared disks which allows high-speed mapping of VLA data. It is most useful for large spectral line projects but also provides continuum capability that is not available in other systems. The Pipeline has had a chequered history over the past several years because of problems with hardware and very special-purpose software required for a complex interconnection of many different modules. However, the Pipeline has been in fairly regular use by observers for about a year and has produced many useful results.

The Pipeline system will be operated in a limited-use mode for the remainder of 1985. Specific observing programs, whose size or character requires use of the capacity of the Pipeline, will be targeted and the observers will be well supported in use of this system. Data will not routinely be filled into the Pipeline; the Pipeline's major role during the remainder of the year will be for map making. These decisions were forced by operational difficulties.

With the conversion to the latest operating system on the DEC-10, it was possible to connect the full Pipeline system o Ethernet, allowing high-speed communications ybetween all PDP-11 and VAX systems at the VLA. A major upgrade to the image display section of the Pipeline was ordered at the end of the quarter. Due for delivery in the late summer, the upgrade consists of a replacement of the present PDP-11/44 with a VAX 11/750 system, allowing the AIPS system to be used to process Pipeline images.

DEC-10 System

During the quarter new disk drives were purchased and installed on the DEC-10 system. Two high-capacity drives replaced seven older drives. The total disk storage capacity has not increased or decreased but the new drives save maintenance charges, floor space and power consumption while allowing more flexibility in disk space management and remote use of the DEC-10 by observers. The latest revision of the DEC operating system, TOPS-10 Version 7.02, was also installed. The new system has much improved the DECnet communications between the DEC-10 and the PDP-11's and VAX's and allows full functioning of the four dial-in DEC-10 terminal lines used for remote observing. At the end of the quarter, two new DEC high-density tape drives were ordered for the DEC-10 system. These drives will increase the efficiency of data storage at the VLA and allow less operator intervention in handling of data tapes.

VAX Systems

The VLA VAX systems continue to be heavily loaded with data processing using AIPS. In addition, they are becoming vital to the NRAO digital communications network. During the quarter, DECnet communications were established with the Cray system at Vector Productions in Los Angeles to facilitate the development of AIPS software on that system. The VLA VAX's have also been established in a separate DECnet area in order to effectively deal with the hundreds of nodes accessible via the connection to Caltech. New hardware includes the purchase of a laser printer to be used for text and graphics output and additional disk drives to bring the complement on each VAX system to about 2 Gigabytes of mass storage. An automated scheme for daily updates of the AIPS software on both VLA VAX's was implemented by the AIPS group in Charlottesville and is performing well.

M. AIPS

Progress was made in AIPS in a variety of areas. Most visible to the user were (1) a coherent system for image alignment in all tasks using more than one input image; (2) a reverse blanking option in all "blotch" algorithms; (3) recording of version number and time of plots in the plots themselves and in the history file; and (4) numerous improvements to the image combination and display tasks. New tasks for model fitting in the uv plane and geometry conversion also appear. The Cray and Unix implementations have made progress both for themselves and as tests of the quality and correctness of the code. Studies of vectorization have led to improvements in the "Q" routine libraries which will, when they are fully implemented, improve performance even in the scalar pseudo-array processor mode used at many non-NRAO AIPS sites. The new three-version system for managing the code has been implemented and the daily updating of the code at the VLA site has worked well at least some of the time.

N. SUPERCOMPUTER INITIATIVE

Cray Project

Work is continuing on the Cray X/MP computer located at Vector Production in Los Angeles. Originally, 40 service units were made available on this machine through the National Science Foundation Supercomputer Access Program. The NRAO has submitted a new proposal for an additional 160 service units. This time has been informally granted and the new work begun. There is some question as to whether the full 160 units will exceed the NSF's current contract with Vector. Also a new, more attractive billing algorithm may reduce the need for the full 160 units. Some clarification remains to be made.

Work remains concentrated in two areas. Processing of limited amounts of test data using stand alone programs has been done. Also work is proceeding on the development of the AIPS software package on the system.

The NSF has been notified that beginning 1986 we hope to support some level of routine processing on this machine. However, a formal time request for the work has not yet been made and awaits further work.

Using the stand-alone programs, a film has been made showing processing results at successive iterations of deconvolution of Cassiopeia A data. Both CLEAN and VM algorithms were used. In addition to producing an impressive film, this work led to some interesting technical results. Some previously unnoticed calibration problems with the data were detected. Also a transient artifact in the clean algorithm was seen, an unexpected observation.

O. VERY LONG BASELINE ARRAY

Project Management

Following the May 15 release by NSF of $9,000,000 to cover the Project construction phase during the period April 1 through December 31, a review and update of overall Project budget and manpower planning was undertaken. The goal is to promote efficient use of funds anticipated under the revised program plan submitted at NSF request on February 13, 1985.

A regularly updated detailed schedule for Station #1 (Pie Town, NM) has been developed and is in use for tracking all phases of the equipment development and construction.

Systems Engineering

This group, with help from other senior Project members, has been involved primarily in reviewing the work of other groups to ensure conformity to specifications, compatibility of interfaces, and general appropriateness of designs. Recent efforts have included (a) detailed review of the design reports of the Data

Recording group and the Correlator group, (b) assisting in the design of the interface between the receiver front ends and the Monitor/Control system, (c) help in the preparation of the specification and RFP for the maser frequency standard, (d) study of methods of calibrating the gains of VLBA receivers, and (e) participation in Quasat and European VLBI Network (EVN) discussions regarding compatibility with the VLBA.

Sites

Preliminary site work and building design drawings with cost estimates for construction at the Pie Town Station (Site #1) have been received from the A/E contractor, Stevens, Mallory, Pearl and Campbell, and are under review. Completion of analysis of the soils has complemented work on the design of the first (and typical) antenna foundation, a sensitive item in which the antenna contractor plays an important part.

An exact location on Kitt Peak for Site #2 is being sought where winds are at a minimum. RFI reports issued for Site #3 (Los Alamos, NM), Site #5 (Fort Davis, TX), and Site #7 (North Liberty, IA) show no significant problems. An exact location for Site #3 has been chosen, and a description is being developed preparatory to a formal arrangement for the property. Exact locations have not been fixed for Sites #5 and #7. A suitable location for Site #6 may have been found in the Virgin Islands.

Antennas

Representatives of Radiation Systems, Incorporated (RSI) and Universal Antennas, Inc. (UAI), a subsidiary of RSI, were at NRAO, Charlottesville June 26-27 for a review of the antenna design work thus far. The review covered configuration and access, drive design and predicted gravity deflections and pointing performance. NRAO and RSI/UAI signed a subcontract change order authorizing manufacture of the first antenna (Phase 2, Subcontract VLBA-100).

At the same meeting, the revised order of site installations developed by NRAO was reviewed with the contractor for feasibility. The contractor foresees no cost increase from the revision.

Design is proceeding on schedule, with design and specification control drawings more than 60% complete, and details over 30% complete. Specifications for gear reducers have been issued, quotations received, and a vendor tentatively chosen. Electrospace Systems, Inc. (ESI) has the servo design about half completed. Other component specifications are in preparation or in the approval stage.

Electronics

Cool-down tests of the front end for the 1.5 GHz band using the CTI Model 350 refrigerator took place in May. The polarizer reached stable operating temperature in 16 hours, while the amplifier required but 7 hours. Further work on thermal connections is expected to reduce the 16 hour figure. These tests show a factor of two improvement in cool-down time over that achieved earlier with the CTI Model 22, which remains the unit of choice for the higher-frequency, mechanically smaller front ends. Work has commenced on prototypes of two of these, for the 4.8 and 10.7 GHz bands.

In progress is the testing of components for the low frequency (330 and 610 MHz) front ends, and for the mixers and IF amplifiers. A prototype model of the dipole feed assembly which will cover both 330 and 610 MHz has been tested at the VLA. Measurements of the radiation pattern indicate that the aperture efficiency will be satisfactory.

A breadboard model of the 2-16 GHz synthesizer that will provide incremental receiver tuning at the antenna has been satisfactorily tested. Modular packaging for this unit is being constructed.

A specification and request for proposals to provide hydrogen maser frequency standards for the VLBA has been forwarded to six potential suppliers. Proposals are due by August 1, 1985.

Data Recording

NRAO has received and reviewed NEROC Haystack Observatory's report on the design of the Data Acquisition (DAS) and Data Playback (DPS) Systems, together with their cost estimates for producing nine sets of DAS equipment for the last nine stations, and 21 DPS units to be used with the Correlator. NRAO has authorized Haystack to proceed with the manufacture and test of a prototype DAS set and DPS unit (Phase 2 of the contract). This first DAS will be available in July, 1986, in time for overall pre-installation system tests of all station equipment destined for Station #1. The prototype DPS will finally serve as one of the 22 required for the Correlator.

In their report, Haystack has offered several cost-saving options entailing, of course, reduced system capability, but no decision has yet been made with respect to these.

Monitor/Control

The Monitor/Control efforts have remained primarily on design.

In hardware, a prototype set of the differential version of the standard interface board was constructed and tested. The artwork for the printed circuit board of the single-ended version has been done, and the prototypes will shortly be made amd tested.

In software, some lower level routines which will be useful in any case (date, time, and angle conversions) have been written. Design investigations are continuing in the areas of screen management (for the operator interface screens), and the software support of the station monitor/control bus.

Correlator

The Correlator group at Caltech completed their reports on Correlator architectural design, cost estimates and projected funding schedule, and continued their efforts to provide a suitable VLSI chip for use in the correlator.

The design proposed in the Architectural Design Report will accept up to 24 Data Playback Systems, each with 16 channels 8 MHz wide. A crossbar switch presents these inputs to the correlator on a channel-by-channel basis, i.e., 16 inputs with 20

stations per input. The inputs to the correlator are switched to provide 10/14/20 station capability in the full/half/quarter mode, as well as the various observing options. Correlator outputs are digitally filtered to compress the data rate, and then passed to the transform output processor (TOP). The TOP uses a high-speed I/O processor controlled by the correlator control computer. The I/O processor routes the data into an array processor, and then to the output tape recorders. Data are stored on archive and distribution tapes for further processing.

Caltech now estimates the overall cost of the Correlator at $6.5M, of which $4.3M represents labor, in a program requiring five years. A list of positive and negative cost options has also been offered.

The conceptual design of a VLSI chip based upon 2-micron gate array technology was completed. The correlator chip would have some 6,000 gates and have 8 complex lags each, with associated fringe rotators, vernier delay and accumulators. Smaller gate arrays would be used in the crossbar and other switching applications.

Caltech has also considered for the correlator the VLSI chip being developed by AUSTEK for the Australian Telescope (AT) Array. However, it now appears that AUSTEK could supply a chip more suited to the Caltech-planned architecture than the AT chip at nearly the same cost. When AUSTEK provides actual cost figures, Caltech will determine the effect on overall correlator cost of opting for such a chip.

Data Processing

Much of the software needed for processing VLBA data is available and in production use. Areas in which further development is needed are: 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., for astrometry and geodesy. Progress in each area is outlined below.

1) The output of the correlator will be written onto an archive medium with data internally in the FITS (Flexible Image Transport System) format, but with some rearrangement of the parts of the file, and protection by an error correction code. At a later stage, the archived data will be sorted and written to a standard FITS format distribution tape. Considerable progress has been made in defining the details of this tape.

2) Much of the system level work inside NRAO's Astronomy Image Processing System (AIPS) required for calibration and editing of VLBA data has been done, and a small amount of application code has been written.

3) The level to which NRAO will support geometric data reduction has not yet been determined. To date, most attention has been given to determining what information, to what accuracy, is necessary to preserve complete geometric accountability. These requirements will be included in the distribution tape and calibration software.

O. ORGANIZATION

On 1 July, 1985, several organizational changes took effect. These changes were made to provide good management of the VLBA Project while preserving the traditional emphasis at the Observatory in the development of new radio astronomy instrumentation. (See Appendix B.)

VLBA is now a free-standing project with H. Hvatum as Associate Director/Project Manager. H. Hvatum is no longer responsible for Technical Services.

What was formerly Technical Services has been reorganized as follows:

- The electronics group in Green Bank now reports to the Green Bank Site Director, G. Seielstad;

- The electronics group in Tucson now reports to the Tucson Site Director, D. Hogg;

- The Computer Division now reports to R. Brown;

- The Engineering Division has been distributed to the VLBA Project and Green Bank Operations;

- S. Weinreb has been appointed Assistant Director for Technical Development; and

- M. Balister, as Chief Engineer, reports to S. Weinreb and has the responsibility for the administration of the Central Development Laboratory and special projects.

Finally, R. Havlen, as Head of Observatory Services, now reports to R. Brown.

P. PERSONNEL CHANGES

The following new appointments, promotions, and departures occurred during the reporting period.

Appointments

R. J. Maddalena	Systems Scientist	Operations - GB
A. Kashlinsky	Vis. Research Associate	Basic Research - CV

Change in Status

R. L. Brown	to Assoc Director, Opns/ Scientist	Directors Office - CV
W. F. delGiudice	to Head/Engr & Services	Engr Services - SO
R. Molina	to Tech Specialist I	Engr Services - SO

E. G. Egler	to Facilities Eng. I/ Asst Div Head	Engr Services - SO
R. G. Stidstone	to Antenna Eng I/Assoc Div Head	Engr Services - SO
A. O. Braun	to Sr Syst Anyl/Assoc Div Head	Computer - SO
D. S. Bagri	to Syst Engr I	Electronics - SO

Leave of Absence

G. C. Hunt	Head/VLA Computer Division

Departures (end of contract)

L. W. Batrla	Vis Systems Scientist	Sci Services - GB
F. O. Clark	Vis Assoc Scientist	Basic Research - CV
G. L. Verschuur	Vis Assoc Scientist	Basic Research - CV

APPENDIX A

AUTHOR (S)	TITLE
BANIA, T.M.	A Latitude Survey of Carbon Monoxide Emission near the Galactic Center
BARTHEL, P.D.; MILEY, G.K. SCHILIZZI, R.T.; PREUSS, E.	Two-Epoch Observations of the Core Radio Structure in Extended Quasars
BIRETTA, J.A.; COHEN, M.H. HARDEBECK, H.E.; KAUFMANN, P. ET AL	Observations of 3C 273 with High North-South Resolution
BLITZ, L.	Molecular Clouds in M31 and M33
BOCKELEE-MORVAN, D.; CROVISIER, J. GERARD, E.; HENKEL, C. ET AL	Radio Observations of OH in Comet Crommelin 1983n
BOUGHN, S.P.; SAULSON, P.R. WILKINSON, J.M.	The Smoothness of the 2.2 micron Background: Constraints on Models of Primeval Galaxies
BROWN, R.L.	Radio Observations of HII Regions
CONDON, J.J.; HUTCHINGS, J.B. GOWER, A.C.	HI Emission from Quasar Host Galaxies
CORDES, J.M.	Space Velocities of Radio Pulsars from Interstellar Scintillations
DE PATER, I.; SCHLOERB, F.P. JOHNSON, A.H.	A Catalog of Radio Sources to Be Occulted by Comets P/Halley and P/Giacobini-Zinner
DEWEY, R.J.; TAYLOR, J.H. WEISBERG, J.M.; STOKES, G.H.	A Search for Low-Luminosity Pulsars
FABIAN, A.C.; ARNAUD, K.A. NULSEN, P.E.J.; WATSON, M.G. ET AL	An X-ray, Optical and Radio Study of PKS 0745-191: A Massive Cooling Flow
FERETTI, L.; GIOVANNINI, G.	The Short Wide Angle Tail Radio Source in NGC4874
GIOVANNINI, G.; FERETTI, L. ANDERNACH, H.	VLA Observations of the Extended Source Near Coma A
GOSS, W.M.; SCHWARZ, U.J. VAN GORKOM, J.H.; EKERS, R.	The Sgr A East HII Complex at long.=-0.02 deg., b=-0.07 deg.
GREISEN, E.W.; LISZT, H.S.	Small Scale Structure of Interstellar HI Clouds

ALL PREPRINTS

AUTHOR(S)	TITLE
HENRY, J.P.; CLARKE, J.T. BOWYER, S.; LAVERY, R.J.	Chacterization of X-ray Sources Detected in a Deep Einstein Exposure of the Field Around 3C 295
HJELLMING, R.M.	The Radio-Emitting Wind, Jet, and Nebular Shell of AG Pegasi
HJELLMING, R.M.	The Radio Emission of VV Cephei-Type Binaries
HJELLMING, R.M.; JOHNSTON, K.J.	Radio Emission from Strong X-ray Sources
HOLLIS, J.M.; OLIVERSON, R.J. KAFATOS, M.; MICHALITSIANOS, A.G.	Evidence for Extended Radio Emission Surrounding RX Puppis
HUGHES, V.A.	Observational Evidence on the Early Development of Stars in Cep A
KUNDU, M.R.; HJELLMING, R.M.	Summary of the Current and Future Problems in Radio Stars
KUNDU, M.R.; SHEVGAONKAR, R.K.	Multiwavelength Observations of a Preflare Solar Active Region Using the VLA
KUNDU, M.R.; SHEVGAONKAR, R.K.	Microwave Emission from Late Type Dwarf Stars UV Ceti and YZ CMi
KUTNER, M.L.; MACHNIK, D.E. MEAD, K.N.; EVANS, N.J. II	High Resolution Studies of the HII Region/Molecular Cloud Interface in NGC 1977
LANDECKER, T.L.; HIGGS, L.A. ROGER, R.S.	High-Resolution Radio Observations of the Supernova Remnants CTB 104A (G93.7-0.3) and 3C 434.1 (G94.0+1.0)
LANG, K.; WILLSON, R. PALLAVICINI, R.	VLA Observations of Late-Type Stars
LESTRADE, J.F.; PRESTON, R.A. MUTEL, R.L.; NIELL, A.E. ET AL	Linking the Hipparcos Catalog to the VLBI Inertial Reference System: High Angular Resolution Structures and VLBI Positions of 10 Radio Stars
LINFIELD, R.P.	VLBI Observations of the Jet in Cygnus A
LOCKMAN, F.J.; HOBBS, L.M. SHULL, J.M.	The Extent of the Local HI Halo

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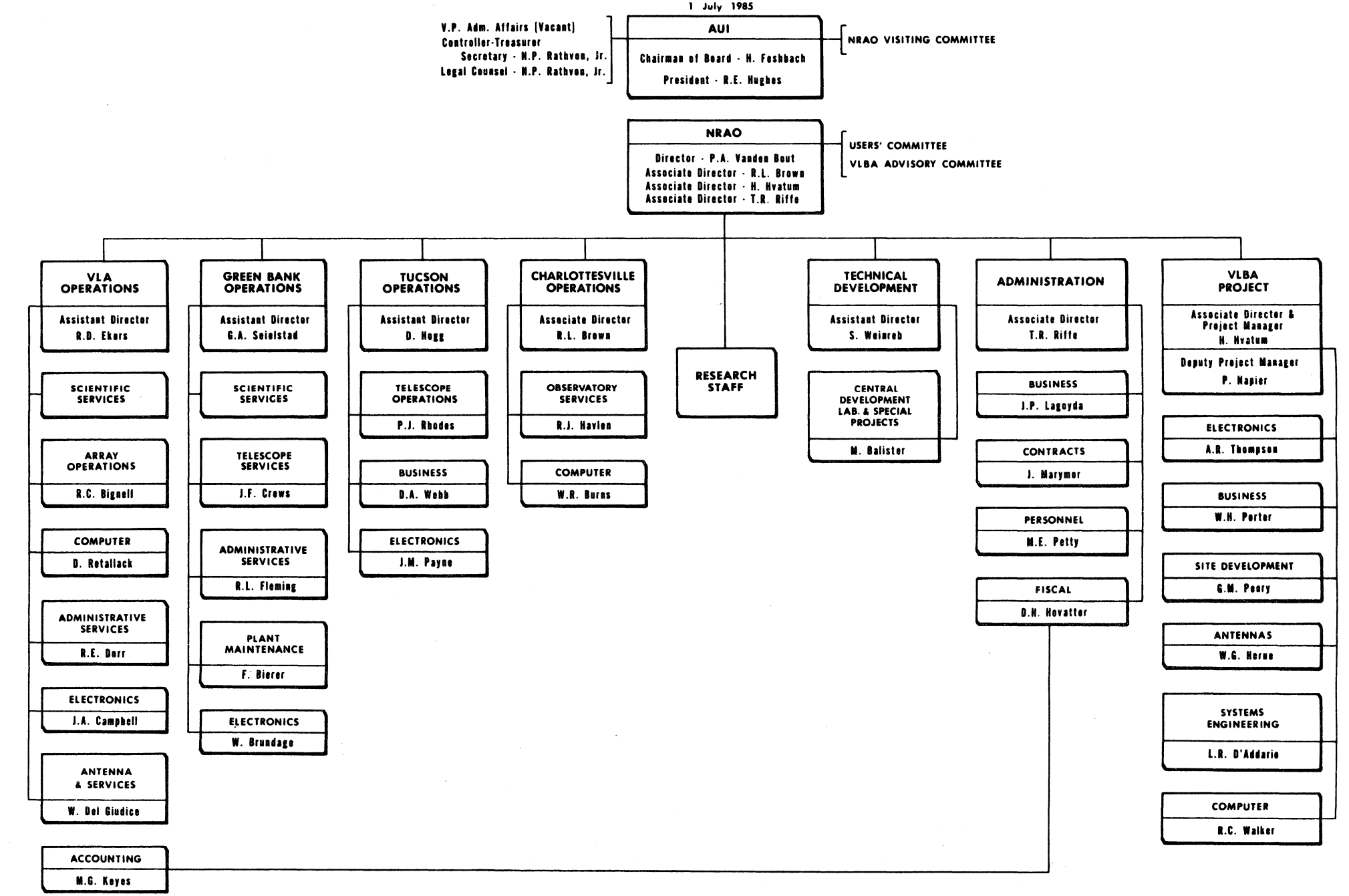
AUTHOR(S)	TITLE
LOCKMAN, F.J.; JAHODA, K. MCCAMMON, D.	The Structure of Galactic HI in Directions of Low Total Column Density
LOREN, R.B.; WOOTTEN, A.	High Excitation Lines of Deuterated Formaldehyde (HDCO) in the Orion Molecular Cloud
MARCAIDE, J.M ; BARTEL, N. GORENSTEIN, M.V.; SHAPIRO, I.I. ET AL	The Quasar 4C39.25 Is Not Contracting
MITCHELL, K.J.; CONDON, J.J.	A Confusion-Limited 1.49 GHz VLA Survey Centered on alpha = 13h 00m 37s, delta = +30 deg 34 min
ONDRECHEN, M.P.	Radio Continuum Observations of the Bar and Disk of M83
OWEN, F.N.; O'DEA, C.P. INOUE, M.; EILEK, J.A,	VLA Observations of the Multiple Jet Galaxy, 3C 75
PADMAN, R.; SCOTT, P.F. WIZARD, D.R.; WEBSTER, A.S.	CS 5-4 Observations of OMC1: Evidence for External Heating of the Quiescent Gas
PALLIVICINI, R.; WILLSON, R.F. LANG, K.R.	Microwave Observations of Late-Type Stars with the Very Large Array
PINEAULT, S.; PRITCHET, C.J. LANDECKER, T.L.; ROUTLEDGE, D. VANELDIK, J.F.	Optical and Radio Imaging of the Supernova Remnant VRO 42.05.01 (G166.0+4.3)
ROLAND, J.; HANISCH, R.J. VERON, P.; FOMALONT, E.	WSRT and VLA Observations of Very Steep Spectrum Radio Galaxies in Clusters
SASLAW, W.C.	Thermodynamics and Galaxy Clustering: Relaxation of N-body Experiments
SCHMAHL, E.J.; KUNDU, M.R. DENNIS, B.R.	Microwave Imaging of a Solar Limb Flare: Comparison of Spectra and Spatial Geometry with Hard X-rays
SCHWARTZ, P.R.	Radio Observations of Bright Ionized Rims
SCHWARTZ, P.R.; FRERKING, M.A. SMITH, H.A.	Pedestal Features in Dark Clouds: A Search for Radio Emission
SCHWARTZ, P.R.; SIMON, T. CAMPBELL, R.	The T Tau Radio Source II: The Winds of T Tau

ALL PREPRINTS

AUTHOR (S)	TITLE
SIMON, T.; FEKEL, F.C. JR GIBSON, D.M.	AY Ceti: A Flaring, Spotted Star with a Hot Companion
SPANGLER, S.R.; MUTEL, R.L. BENSON, J.M.; CORDES, J.M.	Interstellar Scattering of Compact Radio Sources near Supernova Remnants
STOCKE, J.T.; LIEBERT, J. SCHMIDT, G.D.; GIOIA, I.M. ET AL	The Optical and Radio Properties of X-ray Selected BL Lac Objects
STOKES, G.H.; TAYLOR, J.H.	A New Binary Pulsar in a Highly Eccentric Orbit
STRAKA, W.C.; DICKEL, J.R. BLAIR, W.P.; FESEN, R.A.	A Comparison of High Resolution Radio and Optical Data for the Northeast Region of the Cygnus Loop
TAKALO, L.O.; NOUSEK, J.A.	E2000+23: A Newly Discovered Old Nova?
TROLAND, T.H.; CRUTCHER, R.M. HEILES, C.	Molecules and Dust towards Cassiopeia A
TYTLER, D.; BROWNE, I.	3C 159: A Double Emission-Line Radio Galaxy
WADIAK, E.J.; WILSON, T.L. ROOD, R.T.; JOHNSTON, K.J.	VLA Observations of Formaldehyde Emission from Rho Ophiuchi B
WHITE, R.L.; BECKER, R.H.	MWC349: A Bipolar Nebula with a Very Hot Central Star
WILLSON, R.F.	VLA Observations of Solar Active Regions at Closely Space Frequencies: Evidence for a Thermal Cyclotron Line Emission
WILSON, A.S.; SAMARASINHA, N.H. HOGG, D.E.	Magnetic Fields in the "Jet" of the Crab Nebula
WYNN-WILLIAMS, C.G.; BECKLIN, E.E. SCOVILLE, N.Z.	The 3 kpc Radio Disk and Halo of NGC 1068

NATIONAL RADIO ASTRONOMY OBSERVATORY
ORGANIZATION CHART
1 July 1985



APPENDIX B