

(71)

National Radio Astronomy Observatory
Green Bank, West Virginia

Quarterly Report
April 1 - June 30, 1963

Research Programs

The major program on the 300-foot telescope during this period was the polarization work carried out by a group from the Radio Astronomy Branch of the Naval Research Laboratory. They observed more than 100 sources for possible polarization. Total instrumental polarization, of reflector and feed, was only of the order of 1%.

Dr. von Hoerner completed his study of noise levels in the 200-400 mc/sec frequency range. The purpose of this work was to select frequencies for occultation observations to be made with the 85-foot telescope. One interesting result was that the noise level is about twice as high during weekdays as it is at night and on weekends. In addition, there is a broad maximum in noise from about 8:00 A.M. to 9:00 A.M. and a very sharp maximum at 4:30 P.M. -- people start work slowly, but stop very abruptly.

Work continued on various programs begun earlier by the staff, including studies of supernova remnants, normal galaxies, discrete sources, and planets. Preliminary reports of most of this work have been given at recent meetings of the AAS, and several are nearing publication. They will not be discussed here.

Summaries of operations of the 85-foot and 300-foot telescopes follow.

85-foot telescope:

Hours scheduled	1122
Equipment Installation and calibration	123
Time lost due to equipment failure, interference and weather	72
Maintenance	218

The scheduled programs were:

750 mc background polarization	1006
--------------------------------	------

Westford observations	20
Tests of Jasik feed	96

300-foot telescope:

Hours scheduled	1844
Equipment installation and calibration	130
Time lost due to equipment failure, interference and weather	123
Maintenance	14

The scheduled programs were:

NRL polarization observations	1184
Survey of 3C sources	596
Supernova remnants, M 31, M 33	64

Equipment Development

Five standard receivers for the multifeed system on the 300-foot telescope were 80% completed at the end of the period. Tests were made on the front-end package, and production of five 1400 Mc feeds were started. The digital output system is 75% complete.

Work on the autocorrelation receiver is progressing on schedule.

The preliminary tests of the 20-channel hydrogen line receiver on the Reber Telescope suggested that some modifications be made. A gain modulator in each channel would be necessary to adjust the zero level, and an increase in the output distribution from two to three decimal digits would be desirable. These modifications have been made and the receiver is again under test.

The low noise 1400 Mc feed developed by Jasik Laboratories was tested on the 85-foot telescope during the latter part of June. The results of this test are now being evaluated.

Two 1400 Mc parametric amplifiers were received; one from Airborne Instruments Laboratory and one from Microwave Physics Corporation. These amplifiers are now under test in the laboratory.

The 5000 Mc maser system was delivered from Airborne Instruments Laboratory. Preparations for mounting the maser on the 85-foot telescope are being made.

Work on three receivers for observation of moon occultations has been started. Bids have been requested for three parametric amplifiers and a three-frequency feed system.

Work on the back-up digital position readout system for the 300-foot telescope has been started. A master digital clock has been designed and constructed. The construction of a phase measuring system has been completed and put into operation.

Work on the electronic systems for the 85-foot interferometer has started.

A program has been initiated to measure absolute noise levels on the site. These measurements are intended for future interference checks.

Different sources of supply of liquid nitrogen have been investigated. As a result, it is planned to lease a liquid nitrogen generator capable of producing seven liters of liquid nitrogen per hour.

Construction

A contract was signed with Blaw-Knox in Pittsburgh, on June 3 to supply the 85-foot radio telescope for the Interferometer project. Preliminary construction of foundations has begun. A program is underway to develop a new type of cable tray to accommodate the 9,000 feet of control wiring necessary for the Interferometer.

Replacement has been made on the 300' telescope of the structural members which were distorted, possibly by winter storms. A utility building has been built to house the new emergency generator for the 300'.

An aerial survey of the Observatory has been undertaken and is nearing completion. Contour drawings and maps should be available soon.

Ground was broken on June 18 for construction of a new warehouse and as of June 28, most of the footings and some of the grade beams had been poured.

The engineering redesign of the 140-foot telescope has been virtually completed. All major components will have been

fabricated and delivered to the site by the end of this calendar year. Their assembly into major substructures on the ground prior to erection is scheduled for completion in early spring of 1964 and the erection of all components in a completed instrument is scheduled before the end of that year. It is anticipated that this instrument will be in useful operation during 1965.

Antenna Design Studies

a) 400-foot transit telescope. The preliminary design for the telescope has been received from the Rohr Corporation, Chula Vista, in the form of a report, twenty-six design drawings and copies of the engineering calculations. The instrument would have the following characteristics:

(i) Diameter and focal length. Diameter 400', mounted on two towers each 143 feet high. Focal length 171.5'.

(ii) Sky coverage. Movement in elevation from the North pole (52° from the zenith) through the zenith to 72° south of the zenith.

(iii) Drive system. A two speed electric drive (75 HP and 40 HP) moving the telescope by quintuple roller chain. The chain tension is maintained by a hydraulic controlled idler system. Drive speeds of $20^\circ/\text{minute}$ for slew and $2.5^\circ/\text{min}$ for inching are provided.

(iv) Service and survival. To operate in up to 25 mph winds with no snow or ice. To be capable of moving to the stow position in 50 mph winds with no snow or ice.

To withstand when stowed 100 mph winds with no snow or ice and 50 mph winds with $1/2"$ of ice load. To withstand 15 lbs per square foot of uniform snow and ice load when stowed in no wind.

(v) Upper frequency limit. The design is for an instrument capable of working at 3000 Mc/s (10 cms wavelength). The present design probably meets this requirement but further work both in optimising the design and calculating deflections is needed before a definite answer can be given.

The design has only recently been received and will require considerable study before definite answers are available as to

the performance and cost of the instrument. The total weight of steel in the design is 5.28 million pounds, of which all but 126,000 lbs. are structural steel.

(b) Technical Research Group, Boston. A contract has been negotiated and let with TRG for a study of the 300-foot transit telescope as a Cassegrain reflector. There is of course no present intention of modifying this telescope from its present form but the study will determine both the probable radio performance of the telescope and the structural feasibility of it as a Cassegrain. It is being undertaken also to allow a comparison to be made between the prime focus and Cass-grain designs for large telescopes.

Personnel

Dr. P. G. Mezger arrived on June 10th for a one year's visit. He is on leave of absence from Siemens & Halske in Germany. He is expert in antenna measurements, parametric amplifiers and low noise devices and this is the area in which he will work at NRAO.

Dr. P. Stumpff from Heidelberg also arrived on May 20th for a year's visit. He is a theoretical astrophysicist.

Publications

As Appendix I to this report is a list of all Observatory Publications up to date. Further lists will be issued from time to time.

Summer Visitors and Summer students

As Appendix II to this report there is a list of scientists who have visited the Observatory in the summer and also a list of graduate and undergraduate students working in the summer program.

APPENDIX I

National Radio Astronomy Observatory Publications

- Vol. 1
- No. 1. A Model of the Orion Nebula Derived from Radio Observations; T. K. Menon, April, 1961.
 - No. 2. Very Large Antennas for the Cosmological Problem I. Basic Considerations; S. von Hoerner, April, 1961.
 - No. 3. Observations of H II Regions at 1400 Mc; C. R. Lynds, May, 1961.
 - No. 4. Very Large Antennas for the Cosmological Problem II. A Reflecting Cross Antenna; S. von Hoerner, May, 1961.
 - No. 5. Observations of Planetary Nebulae at Centimeter Wavelengths; C. R. Lynds, July, 1961.
 - No. 6. The Structure of Fornax A; C. M. Wade, August, 1961.
 - No. 7. Radio Observations of M31 at 1400 Mc; C. R. Lynds, September, 1961.
 - No. 8. Observations of Discrete Sources at 10 cm and 40 cm Wavelengths; D. S. Heeschen and B. L. Meredith, October, 1961.
 - No. 9. Radio Observations of Galaxies; D. S. Heeschen, November, 1961.
 - No. 10. Observations of the Perseus Cluster of Galaxies at 3000 mc; C. R. Lynds and S. Sobieski, December, 1961.
 - No. 11. 10-Cm Observations of Venus in 1961; F. D. Drake, February, 1962.
 - No. 12. A Switched Load Radiometer: Torleiv Orhaug and William Waltman, February, 1962.
 - No. 13. A Study of the California Nebula at 750 Mc/s; Yervant Terzian, September, 1962.
 - No. 14. The Effect of Atmospheric Radiation in the Microwave Region; T. Orhaug, October, 1962.

- No. 15. The Structure of NGC 5128; Hugh M. Johnson, February, 1963, pp. 251-260.
- No. 16. The Expansion of the Amorphous Part of the Crab Nebula; H. M. Johnson, Vol. 1, p. 261, May, 1963.

NRAO Reprint Series A

- No. 1. The Telescope Program for the National Radio Astronomy Observatory at Green Bank, W. Va.: R. M. Emberson and N. L. Ashton; Proc. of the IRE, Vol. 46, No. 1, January, 1958.
- No. 2. Noise Levels at the National Radio Astronomy Observatory: J. W. Findlay; Proc. of the IRE, Vol. 46, No. 1, January, 1958.
- No. 3. Extragalactic 21-cm Line Studies: D. S. Heeschen and N. H. Dieter; Proc. of the IRE, Vol. 46, No. 1, January, 1958.
- No. 4. Radio Resolution of the Galactic Nucleus: F. D. Drake, Sky and Telescope, Vol. 18, No. 8, June, 1959.
- No. 5. National Radio Astronomy Observatory: R. M. Emberson; Science, Vol. 130, No. 3385, pages 1307-1318, November 13, 1959.
- No. 6. Radio Astronomy Receivers: F. D. Drake; Sky and Telescope, Vol. 19, No. 1 and 2, November and December, 1959.
- No. 7. Astrophysics; Otto Struve, Encyclopaedia Britannica, 1961.
- No. 8. Spectroscopy, Astronomical; Otto Struve, Encyclopaedia Britannica, 1961.
- No. 9. Radio Emission from the Planets; F. D. Drake, Physics Today, Vol. 14, No. 4, 30-34, April, 1961.
- No. 10. Project Ozma: F. D. Drake, Physics Today, Vol. 14, No. 4, 40-42, 44, 46, April, 1961.
- No. 11. Vertical Incidence Doppler Ionogram; J. W. Findlay IRE Proc. Vol. 49, July, 1961.

- No. 12. The Search for Signals from Other Civilizations; Sebastian von Hoerner, Science, Vol. 134, No. 3493, pp. 1839-1843, December 8, 1961.
- No. 13. National Radio Astronomy Observatory Report; Otto Struve, A. J. 66, No. 9, 1961, November, No. 1294.
- No. 14. A Study of the Region of M17 at a Wavelength of 3.75 cm; R. W. Hobbs, A.J. 66, No. 9, 1961, November, No. 1294.
- No. 15. Radio Galaxies; D. S. Heeschen; Scientific American Vol. 206, No. 3, March, 1962, pp. 41-49.
- No. 16. Protecting the Science of Radio Astronomy; J. W. Findlay, Science, Vol. 137, pp. 829-835, September 14, 1962.
- No. 17. National Radio Astronomy Observatory Report; D. S. Heeschen, A.J. 67, No. 10, 777, December, 1962.
- No. 18. The 300-Foot Radio Telescope at Green Bank; John W. Findlay, Sky & Telescope, Vol. 25, No. 2, February, 1963.
- No. 19. Fluctuation Component of Atmospheric Noise Temperature; Torleiv Orhaug, Proc. of the IEEE, Vol. 51, No. 3, March, 1963.
- No. 20. The 300-foot Transit Telescope at the National Radio Astronomy Observatory; John W. Findlay, A.J. 68, No. 2, March, 1963.
- No. 21. Radio Observations of Supernovae Remnants; D. E. Hogg, A.J. 68, No. 2, March, 1963.
- No. 22. Measurements of Radio Sources in the 3C Catalogue; D. J. Crampin, D. S. Heeschen, I.I.K. Pauliny-Toth, C. M. Wade, A.J. 68, No. 2, March, 1963.
- No. 23. Structure of NGC 5128; Hugh M. Johnson, A.J. 68, No. 2, March, 1963.

- No. 24. The Wavelengths of Helium Lines in the Spectrum of 21 Aquilae; O. Struve, G. Wallerstein, and V. Zebergs, PASP, Vol. 73, No. 432, June, 1961.
- No. 25. A Contour Map of IC 443 at 1400 Mc/s; James F. Wanner PASP, Vol. 73, No. 431, April 1961; pp. 143-146.
- No. 26. Some Features of M84 and M87 Observed at 10 cm Wavelength; To the Editors of "The Observatory"; C. M. Wade, The Observatory, Vol. 81, No. 924, pp. 202-203, (1961)
- No. 27. A Study of the Rosette Nebula NGC 2237-46; T. K. Menon, Ap. J. Vol. 135, No. 2, March, 1962, pp. 394-407.
- No. 28. Sound Waves Trapped in the Solar Atmosphere. II; F. D. Kahn, Ap. J., Vol. 135, No. 2, March 1962, pp. 547-551.
- No. 29. Catalogue of Dark Nebulae; Beverly T. Lynds, Ap. J. Supplement Series, Vol. VII, No. 64, May 1962; pp. 1-52.
- No. 30. Physical Conditions in the Orion Nebula; T. K. Menon, Ap. J., Vol. 136, No. 1, July 1962. pp. 95-99.
- No. 31. On the Evolution of Galaxies; Otto Struve, Reprinted from Symposium on Stellar Evolution, La Plata Observatory, Argentina; pp. 291-306, 1962.
- No. 32. Microwave Spectrum of Saturn; 10-cm Observations of Venus near Superior Conjunction; F. D. Drake, Nature Vol. 195, No. 4844, pp. 893-894, September 1, 1962.

NRAO Reprint Series B

- No. 1. Neutral Hydrogen Emission from the Hercules and Corona Borealis Cluster of Galaxies; D. S. Heesch; PASP, Vol. 69, No. 409, August, 1957.
- No. 2. Neutral Hydrogen in M32, M51 and M81; D. S. Heesch, Ap.J. Vol. 126, No. 3, November, 1957.
- No. 3. Radio Astronomy and the New National Observatory; R. M. Emberson, Transactions of the N. Y. Academy of Sciences, Ser II, Vol. 22, No. 6, Pages 419, 425, April, 1960.
- No. 4. Radio Astronomy: A Window on the Universe; J. H. Oort, American Scientist, Vol. 48, No. 2, June, 1960.
- No. 5. Wavelengths of Absorption Lines in the Spectra of Beta Canis Majoris Stars; O. Struve and V. Zeberg; Ap.J. Vol. 132, No. 1, July, 1960.
- No. 6. A Color-Absolute Magnitude Diagram for Extragalactic Radio Sources; D. S. Heesch, PASP, Vol. 72, No. 428, October, 1960.
- No. 7. Spectroscopic Features of β Lyrae; Otto Struve and MaryJane S. Wade; PASP, Vol. 72, No. 428, October, 1960.
- No. 8. Observations of Radio Sources at Four Frequencies; D. S. Heesch, Ap. J. Vol. 133, No. 1, January, 1961.
- No. 9. Photometry and Radiometry of Gaseous Nebulae; Donald E. Osterbrock and Ralph E. Stockhausen; Ap. J. Vol. 133, No. 1, January 1961.
- No. 10. A Note on the Brighter Pleiades (Correspondence to the Editors of 'The Observatory') Otto Struve and MaryJane Wade; The Observatory Vol. 80, No. 919, pp.229-232.
- No. 11. The Radial Velocity of Sigma Scorpii; O. Struve, J. Sahade, and V. Zeberg; Ap. J., Vol. 133, No. 2, March, 1961.
- No. 12. A Possible New Radio Galaxy in the Virgo Cluster; The Observatory, Vol. 80, No. 919, pp. 235-236., C. M. Wade.

- No. 13. The Nonconstancy of the Adiabatic Invariants; Peter O. Vandervoort; Annals of Physics, Vol. 12, No. 3, March, 1961, pp. 436-443.
- No. 14. The Spectrum of the B8 Component of Beta Lyrae; O. Struve and V. Zeberg; Ap. J. Vol. 133, No. 2, March, 1961.
- No. 15. The 140-Foot Radio Telescope of the National Radio Astronomy Observatory; O. Struve, R. M. Emberson, and J. W. Findlay; PASP, Vol. 72, No. 429, December, 1960.
- No. 16. The Position-Determination Program of the National Radio Astronomy Observatory; F. D. Drake, PASP, Vol. 72, No. 429, December, 1960.
- No. 17. Secular Variation of the Flux Density of the Radio Source Cassiopeia A; D. S. Heeschen and B. L. Meredith; Nature, Vol. 190, No. 4777, pp. 705-706, May 20, 1961.
- No. 18. The Spectrum of the B8 Component of Beta Lyrae. II. Otto Struve and V. Zeberg, Ap. J. 134, No. 1, July, 1961.
- No. 19. Sound Waves Trapped in the Solar Atmosphere; F. D. Kahn, Ap.J. 134, No. 2, September, 1961.
- No. 20. Radio Observations of the Peculiar Galaxy M82; C. R. Lynds, Ap.J. 134, No. 2, September, 1961.
- No. 21. The Character of the Equilibrium of a Compressible, Inviscid Fluid of Varying Density; Peter O. Vandervoort, Ap.J. Vol. 134, No. 3, November 1961, pp.699-717.
- No. 22. Evolution of Gaseous Nebulae; F. D. Kahn and T. K. Menon, Proc. Nat. Acad. Sci. Vol. 47, No. 11, pp. 1712-1716, November, 1961.
- No. 23. Commission V. - On Radio Astronomy - "Protecting Frequencies for Radio Astronomy", John W. Findlay, U.R.S.I. Information Bulletin, No. 124, (1961).

APPENDIX II

Summer Visitor to the NRAO - 1963

J. Bologna, Naval Research Laboratory, May 4 - June 29
B. F. Burke, Carnegie Institution of Washington, Department of
Terrestrial Magnetism, June 23 - August 19
P. A. Mariotto, University of Sao Paulo, June - August
E. F. McClain, Naval Research Laboratory, May 4 - June 29
P. G. Mezger, Siemens & Halske, Munich, June - 1 year
M. S. Roberts, Harvard College Observatory, August 12 - October 1
W. Rose, Columbia University and Naval Research Laboratory,
May 4 - June 29
J. R. Shakeshaft, Cambridge University, June 25 - 27
R. Sloanaker, Naval Research Laboratory, May 4 - June 29
P. Stumpff, Astronomisches Recheninstitut, Heidelberg, May - 1 year
K. Turner, Carnegie Institution of Washington, Department of
Terrestrial Magnetism, June 23 - August 19
C. Varsavsky, University of Buenos Aires, June 25 - 26
H. van Woerden, Groningen and Palomar Observatories, August - 2 weeks.
(Tentative)
G. Westerhout, University of Maryland, June 23 - September
D. R. W. Williams, University of California, August 26 - September 2.

Summer Students at NRAO - 1963

Mark L. Fagerlin, University of Florida
Allen J. Harris, University of Pennsylvania
William F. Gingerich, West Virginia Institute of Technology
Carlson R. Chambliss, University of Pennsylvania
William R. Burns, Jr., Carnegie Institute of Technology
Yervant Terzian, Indiana University
Carl Heiles, Princeton University
Richard R. Weber, University of Maryland

Douglas M. Pease, University of Connecticut

James R. Seebach, Case Institute of Technology

Michael N. Parker, Massachusetts Institute of Technology

Paul M. Thomas, University of Kentucky

Wade M. Poteet, North Carolina State

Robert H. Drake, Cornell University

Elizabeth M. Pike, Vassar

Joseph L. Finch, Texas A. & M.

Jonathan D. Cook, Trinity College, Hartford, Connecticut

Marvin DeJong, Renssellaer Polytechnic

Peter S. Tong, University of Delaware

Jerome J. Cohen, Carnegie Institute of Technology

Edward W. Ng, Columbia University

Jeffrey L. Linsky, Massachusetts Institute of Technology
