

CONTENTS

PREFACE	page ix
---------	---------

CHAPTER I

Introduction to radiotelescopes

- 1.1.** The purpose of a radiotelescope, p. 1. **1.2.** The objects studied by radio-astronomers, p. 2. **1.3.** Filled-aperture radiotelescopes, p. 6. **1.3.1.** The parabolic reflecting antenna, p. 6. **1.3.2.** Other reflector-type radiotelescopes, p. 10. **1.4.** Unfilled-aperture radiotelescopes, p. 12. **1.4.1.** The radio interferometer, p. 13. **1.4.2.** The skeleton radiotelescope, p. 14. **1.4.3.** Aperture synthesis, p. 16. **1.4.4.** Antennas with an incomplete range of spacings and directions, p. 18. **1.4.5.** Independence of sensitivity and resolution, p. 19.

CHAPTER 2

Some theory

- 2.1.** Effective area and antenna polarization, p. 20. **2.2.** Radio brightness, antenna temperature, brightness temperature and some simple associated antenna relations, p. 24. **2.3.** Field pattern and grading, p. 27. **2.4.** Computing antenna patterns: the Fourier transform, p. 31. **2.4.1.** A uniformly graded line antenna, p. 32. **2.4.2.** A uniformly graded large rectangular aperture, p. 34. **2.4.3.** The circular ring and the uniformly graded circular aperture, p. 35. **2.4.4.** Antennas with non-uniform grading, p. 38.

CHAPTER 3

The steerable parabolic reflector (paraboloid of revolution)

- 3.1.** The current grading across the aperture, p. 44. **3.2.** The reflecting surface, p. 50. **3.2.1.** Some effects of departure from ideal shape, p. 51. **3.2.2.** The effects of structural deflections on reflector performance, p. 55. **3.2.3.** Reflectivity of the surface, p. 59. **3.2.4.** Mesh or grating reflectors, p. 61. **3.3.** The feed antenna, p. 64. **3.3.1.** Prime-focus feed, p. 64. **3.3.2.** Multiple feeds and image formation, p. 70. **3.3.3.** The Cassegrain telescope, p. 73. **3.3.4.** Cross polarization, p. 75. **3.3.5.** Multi-frequency feeds, p. 76. **3.4.** Steering the antenna, p. 76. **3.4.1.** The equatorial mount, p. 76. **3.4.2.** The 'altitude-azimuth' mount, p. 77. **3.4.3.** Transit telescopes, p. 79.

CHAPTER 4

Other types of filled-aperture antennas

- 4.1.** Arrays, p. 81. **4.1.1.** The field pattern of an array, p. 82. **4.1.2.** Steering an array, p. 86. **4.2.** Cylindrical paraboloids, p. 89. **4.2.1.** Mechanical features, p. 89. **4.2.2.** Electrical performance, p. 90. **4.3.** Special types of parabolic-reflector antennas, p. 95. **4.3.1.** The Kraus type fixed parabolic reflector, p. 95.

- 4.3.2.** The multiple-plate antenna, p. 97. **4.4.** Spherical reflectors, p. 97.
4.4.1. Correcting mirrors, p. 99 **4.4.2.** Line feed for a spherical reflector, p. 101. **4.5.** Future developments, p. 102.

CHAPTER 5

Some more theory

- 5.1.** Introduction to correlation telescopes, p. 103. **5.2.** The effective area of a correlation telescope, p. 105. **5.2.1.** Definition in terms of the available correlated power, p. 105. **5.2.2.** Relation between A_c and the properties of the component antennas, p. 106. **5.2.3.** Cosine and sine effective area, p. 107. **5.2.4.** Complex form of the effective area: Envelope pattern, p. 109. **5.2.5.** Correlation temperature, p. 110. **5.2.6.** The all-sky integral of the correlation effective area, p. 111. **5.2.7.** Making use of the product pattern: The cross telescope, p. 112. **5.3.** The telescope transfer function, p. 114. **5.3.1.** Introducing the transfer function, p. 114. **5.3.2.** Constructing transfer functions, p. 116. **5.3.3.** Total-power telescopes, p. 117. **5.4.** Measuring the sky brightness distribution with a radiotelescope: Antenna smoothing, p. 119. **5.4.1.** Electrical steering, p. 119. **5.4.2.** Mechanical steering, p. 121. **5.4.3.** Antenna smoothing in terms of the telescope transfer function, p. 121. **5.5.** Broad-band systems, p. 123. **5.5.1.** Broad-band telescope systems, p. 123. **5.5.2.** A simple correlation interferometer, p. 125.

CHAPTER 6

Unfilled-aperture antennas

- 6.1.** Line apertures, p. 127. **6.1.1.** The grating antenna, p. 127. **6.1.2.** The compound grating antenna, p. 132. **6.1.3.** Beam shaping and restoring, p. 144. **6.2.** Two-dimensional unfilled apertures, p. 149. **6.2.1.** The cross antenna, p. 149. **6.2.2.** The T antenna, p. 155. **6.2.3.** The ring antenna, p. 159. **6.3.** Various problems involved in forming a radiotelescope from a number of separate antennas, p. 162. **6.3.1.** Attenuation of power flowing along the transmission lines, p. 162. **6.3.2.** Electrical steering, p. 164. **6.3.3.** Image formation, p. 168.

CHAPTER 7

Aperture synthesis

- 7.1.** The correlation interferometer, p. 171. **7.2.** Methods of synthesis, p. 173. **7.2.1.** The movable pair of antennas, p. 173. **7.2.2.** The use of the rotation of the Earth, p. 178. **7.3.** The use of aperture synthesis methods for extremely high resolution observations, p. 186. **7.3.1.** Long base-line interferometry, p. 816. **7.3.2.** Lunar occultations, p. 188.

CHAPTER 8

Sensitivity

- 8.1.** The limits of detection, p. 190. **8.2.** Random noise, p. 192. **8.2.1.** Bandwidth, integration time and noise fluctuations, p. 192. **8.2.2.** Noise fluctuations and gain stability, p. 194. **8.2.3.** Noise fluctuations and receiver sensitivity, p. 197. **8.3.** Total-power telescopes, p. 197. **8.3.1.** Noise powers in the system, p. 197. **8.3.2.** Noise powers in a system with preamplifiers, p. 199.

CONTENTS

vii

8.3.3. Sensitivity of a total-power telescope with respect to the flux density from a point source, p. 200. **8.3.4.** Sensitivity of a total-power telescope with respect to the brightness of an extended source, p. 201. **8.4.** Correlation telescopes, p. 203. **8.4.1.** A correlation system with preamplifiers, p. 204. **8.4.2.** Sensitivity of a correlation telescope with respect to the flux density from a point source, p. 206. **8.4.3.** Sensitivity of a correlation telescope with respect to the brightness temperature of an extended source, p. 207. **8.5.** Sensitivity of synthesis telescopes, p. 207. **8.6.** Image formation and its influence on the effective sensitivity: Definition of surveying sensitivity, p. 209.

APPENDICES I-4	212
REFERENCES	222
INDEX	227