

CONTENTS

Foreword by Wendee Wallach-Levy xv
Preface to the first edition xvii
Preface to this edition xix
Acknowledgments xxii

Part 1 **Getting started**

1 First night out 1

- 1.1 Discover the sky 2
 - 1.1.1 Aspects of the sky 3
 - 1.1.2 Magnitudes 4
- 1.2 The Big Dipper key 4
- 1.3 The Milky Way 6
- 1.4 The planets 7
- 1.5 Celestial co-ordinates and measurements 7
- 1.6 The star charts 9
- 1.7 Starry, starry skies ... 26

2 Without a telescope 27

- 2.1 Lights 28
 - 2.1.1 Haloes 28
 - 2.1.2 Aurora borealis and australis 28
 - 2.1.3 Zodiacal light and Gegenschein 33
 - 2.1.4 Artificial satellites 34
- 2.2 The planets 34
- 2.3 Diversity of the stars 35
- 2.4 The Sun 37
- 2.5 The Moon 38
- 2.6 Mercury 38
- 2.7 Planets in daylight 38
- 2.8 Variable stars 40
- 2.9 Deep sky objects 41
- 2.10 Searching 42

viii Contents

3 Meteors 43

- 3.1 Showers 44
 - 3.1.1 Showers month by month 45
- 3.2 Observing procedure 50
 - 3.2.1 Single observer 50
 - 3.2.2 Group observing 51
 - 3.2.3 Hints 52
- 3.3 Fireballs 54

4 Choosing a telescope 55

- 4.1 Binoculars 57
 - 4.1.1 Anticipating problems 58
- 4.2 Telescopes 59
 - 4.2.1 Refractor 59
 - 4.2.2 Reflector 61
 - 4.2.3 Compound telescopes 61
- 4.3 Eyepieces 61
- 4.4 Mounts 62
- 4.5 Why not make your own? 62
- 4.6 Extremes 64

5 Telescopes, advanced 65

- 5.1 How to use electronic telescopes 66

6 Recording your observations 67

Part 2 **Moon, Sun and planets**

7 The Moon 73

- 7.1 Why observe the Moon? 74
- 7.2 The phases 75
- 7.3 Training project 75
- 7.4 Day to day notes 77

8 Moon II: advanced observations 86

- 8.1 Crater drawing program 86
 - 8.1.1 Drawing a feature 86
 - 8.1.2 A note about notes 89
- 8.2 Photographing the Moon 89
 - 8.2.1 At the prime focus 91
- 8.3 Lunar transient phenomena 92
 - 8.3.1 Suspect areas 93
- 8.4 Notes on advanced projects 94
 - 8.4.1 Lunar height measurements 95
 - 8.4.2 Viewing difficult features 96

9 The Sun 97

- 9.1 Observing the Sun is dangerous 99

- 9.2 Observing projects 101
 - 9.2.1 Daily sunspot count 101
- 9.3 Other features on the Sun 106
 - 9.3.1 Disk drawings 106
 - 9.3.2 Detailed drawings 108
 - 9.3.3 Photographs 109
- 9.4 Advanced work: hydrogen-alpha filters 110
- 10 Jupiter 110**
 - 10.1 Jupiter and its moons 111
 - 10.2 Seeing 111
 - 10.3 The face of Jupiter 113
 - 10.4 Drawing Jupiter 114
 - 10.4.1 Full disk drawings 115
 - 10.4.2 Specific regions 116
 - 10.5 The Galilean satellites 119
 - 10.6 A comet strikes Jupiter 119
- 11 Saturn 123**
 - 11.1 Historical perspective 124
 - 11.2 The rings 124
 - 11.3 The globe 125
 - 11.4 Drawing Saturn 126
 - 11.4.1 A cloudy night experiment for clubs 126
 - 11.4.2 Actual drawing 127
 - 11.4.3 Estimating conspicuousness 127
 - 11.5 Estimating intensity 127
 - 11.6 The moons 129
 - 11.6.1 Titan 129
 - 11.6.2 Iapetus 130
 - 11.6.3 Phoebe 130
- 12 Mars 131**
 - 12.1 Observing Mars 133
 - 12.2 Drawing Mars 135
 - 12.3 Kinds of changes to expect 136
 - 12.4 Surface features 137
 - 12.4.1 The atmosphere 140
 - 12.5 Phobos and Deimos 141
 - 12.6 Mars thought 143
 - 12.7 The retrograde motion of Mars, by Leo Enright 143
- 13 Five planets worth watching 149**
 - 13.1 Venus 149
 - 13.1.1 Observing Venus 150
 - 13.1.2 Advanced observing 150
 - 13.1.3 Ashen light 152
 - 13.1.4 Transits 152

x Contents

- 13.2 Mercury 153
 - 13.2.1 Observing Mercury 153
- 13.3 How the outer planets were discovered 154
 - 13.3.1 Discovery I: Uranus 154
 - 13.3.2 Discovery II: Neptune 155
 - 13.3.3 Discovery III: Pluto 157
- 13.4 Observing Uranus 158
- 13.5 Observing Neptune 160
- 13.6 Observing Pluto 160

Part 3 **Minor bodies**

14 **Asteroids** 163

- 14.1 Historical perspective 163
- 14.2 Naming of asteroids 165
- 14.3 Observing asteroids 166
- 14.4 Kinds of asteroids 166
- 14.5 Observing asteroids 166
 - 14.5.1 A life list of asteroids 167
- 14.6 Asteroid occultations 167
- 14.7 Physical observations 170
 - 14.7.1 A photometric study of some asteroids 170

15 **Comets** 172

- 15.1 Comets, clouds, and variable stars 172
- 15.2 Comet observers 174
- 15.3 What is a comet? 175
- 15.4 Families of comets 175
- 15.5 Groups of comets 175
- 15.6 Observing comets 176
 - 15.6.1 How to estimate the brightness of a comet 177
- 15.7 The coma 179
- 15.8 Comet hunting 180
- 15.9 Procedures for hunting 182
 - 15.9.1 Sun vicinity 183
 - 15.9.2 Twilight horizon 183
 - 15.9.3 A group search program 183
- 15.10 Hunting with a telescope 184
 - 15.10.1 Search procedures 184
- 15.11 Appropriate times 185
- 15.12 Discovery 186
- 15.13 The naming of comets 188

Part 4 **Deep sky**

16 **Double stars** 191

- 16.1 Mizar 191
- 16.2 Historical notes 192
- 16.3 Nature of doubles 193
- 16.4 Observing double stars 194
 - 16.4.1 Recording your observations 195
 - 16.4.2 Doubles as optical tests 196
 - 16.4.3 The Tombaugh–Smith seeing scale 196
- 16.5 Advanced work 198

17 **Variable stars** 199

- 17.1 The AAVSO 200
- 17.2 Eclipsing binaries 201
- 17.3 Cepheids 202
- 17.4 Long period stars 202
- 17.5 Semiregular stars 203
- 17.6 Cataclysmic variables 206
- 17.7 T Tauri 207
- 17.8 Naming of variables 207
- 17.9 How to observe a variable star 208
- 17.10 Suggested frequency of observation 210
- 17.11 Northern summer program 210
- 17.12 Northern winter program 211
- 17.13 A selection of variable stars 211
- 17.14 Searching for novae and supernovae 216
- 17.15 Neutron star song 222

18 **TV Corvi: A variable star adventure** 223

19 **The deep sky** 225

- 19.1 *The New General Catalogue* 226
- 19.2 Open clusters 226
- 19.3 Globular clusters 229
- 19.4 Diffuse nebulae 232
- 19.5 Planetary nebulae 235
- 19.6 Supernova remnants 237
- 19.7 Galaxies 237
- 19.8 Quasars 238
- 19.9 Telescope and sky 239
- 19.10 For a city sky 239
- 19.11 For a dark sky 242

20 **Messier hunting** 245

- 20.1 Messier marathons 258

xii Contents

- 21 **The sky on film** 262
 - 21.1 Star trails 264
 - 21.2 The Sun 266
 - 21.3 Moon and planets 266
 - 21.3.1 Photographs by projection 266
 - 21.4 Guided astrophotography 267
 - 21.4.1 Camera support 267
 - 21.4.2 What you need 267
 - 21.4.3 Aligning the polar axis 269
 - 21.4.4 Setting up the picture 270
 - 21.4.5 Focusing 270
 - 21.4.6 Ready! 271
 - 21.5 Some advanced ideas 271
 - 21.5.1 Copying 271
 - 21.5.2 Hypersensitizing 271
 - 21.6 Processing film 272
 - 21.7 Some hints 273
- 22 **The electronic revolution, part 1: CCDs** 275
 - 22.1 Connecting a CCD to a computer 277
 - 22.2 Observing with CCDs 277
 - 22.2.1 Focusing 278
 - 22.2.2 Taking the image 278
 - 22.2.3 Flat fielding 279
 - 22.2.4 Image manipulation 279
- 23 **The electronic revolution, part 2: Astrometry** 280
 - 23.1 Some background 281
 - 23.2 Observing the object 282
 - 23.3 Measuring positions the classical way 282
 - 23.4 Using CCDs 283

Part 5 **Special events**

- 24 **Solar eclipses** 285
 - 24.1 Alignments 286
 - 24.2 Solar eclipses and the public 286
 - 24.2.1 Eye protection 287
 - 24.3 The saros cycle 289
 - 24.4 Partial eclipses 290
 - 24.5 Total eclipses 290
 - 24.5.1 Photographing a solar eclipse 291
 - 24.6 Other activities 293
 - 24.7 Annular eclipses 294
 - 24.8 Enjoy it! 295

25 Lunar eclipses and occultations 295

- 25.1 Lunar eclipses 296
 - 25.1.1 Shadows 296
 - 25.1.2 Things to do 297
 - 25.1.3 Penumbral eclipses 300
 - 25.1.4 Thought 300
- 25.2 Lunar occultations 301
 - 25.2.1 Grazing occultations 302
 - 25.2.2 Occultations of planets 304
 - 25.2.3 Occultations by planets 304
 - 25.2.4 Murphy's Law and occultations 304

Part 6 A miscellany**26 Passing the torch 309**

- 26.0.1 Schools 309
- 26.1 Methods of teaching 310
- 26.2 The planets 310
- 26.3 Daytime observing 311
 - 26.3.1 Observing the Sun 312
 - 26.3.2 Venus 312
 - 26.3.3 Observing the Moon 313
- 26.4 Night observing 313
- 26.5 Meteors, and learning through research 314
- 26.6 Closing thought 314

27 The poet's sky 318**28 My favorite objects 323**

- 28.1 The Moon 323
- 28.2 The Sun 324
- 28.3 Jupiter 324
- 28.4 Saturn 324
- 28.5 Algol 325
- 28.6 V Hydrae 325
- 28.7 TV Corvi 326
- 28.8 47 Ursae Majoris 326
- 28.9 Wendee's star 326
- 28.10 Eta Carinae 327
- 28.11 Wendee's Ring 327
- 28.12 Equuleus S 328
- 28.13 IC 1396 328
- 28.14 NGC 1931 328
- 28.15 M17: The Omega Nebula 329
- 28.16 Messier 31 329

xiv Contents

- 28.17 Messier 51: The Whirlpool Galaxy 329
- 28.18 NGC3621: The Frame Galaxy 330
- 28.19 The Hydra Trio: Larry, Mo and Curly 330
- 28.20 Nanette's River 330

Appendix: Resources 331

Societies 331

- Lunar and planetary 331
- Variable stars 331
- Occultations 331
- Photometry 332
- Deep sky 332
- Light pollution 332
- Sun 332
- Three other organizations 333

Literature 333

- Observing assistance 333
- Star atlases 334
- Historical 334
- Solar system 335
- Deep sky 335
- General assistance 336
- For children 336
- Magazines 336

Index 339