

Cambridge University Press

978-0-521-64133-3 - Astrophotography for the Amateur, Second Edition

Michael A. Covington

Table of Contents

[More information](#)

Contents

<i>Preface</i>	xi	3.7 Zodiacal light, Gegenschein, and lunar libration clouds	28
<i>Notes to the reader</i>	xiii	3.8 All-sky cameras	33
<i>Symbols used in formulae</i>	xiv		
I SIMPLE TECHNIQUES	1	4 The moon	35
1 Welcome to astrophotography	3	4.1 Lenses and image size	35
1.1 The challenge of astrophotography	3	4.2 Using a telephoto lens	35
1.2 Choosing equipment	3	4.3 BASIC TECHNIQUE 5: Photographing the moon through a telephoto lens	37
1.3 Sharing your work with others	5	4.4 Determining exposures	38
1.4 Maintaining balance and enjoyment	7	4.5 PRACTICAL NOTE: What is a "stop"?	39
2 Photographing stars without a telescope	8	4.6 Afocal coupling to telescopes and binoculars	40
2.1 Stars and trails	8	4.7 BASIC TECHNIQUE 6: Photographing the moon (afocal method)	43
2.2 BASIC TECHNIQUE 1: Photographing stars without a telescope	10	4.8 Films and processing	44
2.3 How long can you expose?	10	5 Eclipses	46
2.4 PRACTICAL NOTE: How to approach formulae	12	5.1 Lunar eclipses	46
2.5 Choice of camera and lens	12	5.2 Lunar eclipse dates and times	47
2.6 Slides versus prints	14	5.3 Lunar eclipse photography	48
2.7 PRACTICAL NOTE: Getting good color prints	14	5.4 Videotaping a lunar eclipse	50
2.8 Getting the most out of your film	15	5.5 BASIC TECHNIQUE 7: Photographing an eclipse of the moon	52
2.9 Keeping records	16	5.6 Solar eclipses – partial and annular	52
2.10 PRACTICAL NOTE: Film and false economy	18	5.7 Eclipse safety	54
2.11 Interpreting your pictures scientifically	19	5.8 PRACTICAL NOTE: How eclipse eye injuries happen	55
3 Comets, meteors, aurorae, and space dust	21	5.9 BASIC TECHNIQUE 8: Viewing a solar eclipse by projection	55
3.1 Comets	21	5.10 Safe solar filters	56
3.2 BASIC TECHNIQUE 2: Photographing a bright comet	25	5.11 Photographing partial solar eclipses	60
3.3 Meteors	25	5.12 BASIC TECHNIQUE 9: Photographing a partial solar eclipse	60
3.4 BASIC TECHNIQUE 3: Photographing a meteor shower	26	5.13 Solar eclipses – total	60
3.5 Aurorae	28	5.14 Shadow bands and other phenomena	62
3.6 BASIC TECHNIQUE 4: Photographing the aurora borealis	28	5.15 BASIC TECHNIQUE 10: Photographing a total solar eclipse	63
		5.16 Session planning	63
		5.17 Videotaping solar eclipses	63
		5.18 The 1999 total eclipse in Europe	65

Cambridge University Press

978-0-521-64133-3 - Astrophotography for the Amateur, Second Edition

Michael A. Covington

Table of Contents

[More information](#)

viii CONTENTS

II ADVANCED TECHNIQUES	67	8 Deep-sky photography	113
6 Coupling cameras to telescopes	69	8.1 Piggy-backing	114
6.1 Prime-focus astrophotography	69	8.2 BASIC TECHNIQUE 13: Piggy-back deep-sky photography	114
6.2 Telescope types and optical limitations	70	8.3 BASIC TECHNIQUE 14: Polar alignment procedure	118
6.3 Image size and field of view	73	8.4 Barn-door trackers	120
6.4 Afocal coupling	75	8.5 Lenses for deep-sky work	121
6.5 Positive projection	77	8.6 Scale enlargement and edge-of-field fall-off	124
6.6 PRACTICAL NOTE: Measuring s_2 for eyepiece projection	79	8.7 Magnitude limits and surface brightness	126
6.7 Negative projection	80	8.8 Guiding	130
6.8 Compression (focal reducers)	82	8.9 PRACTICAL NOTE: What do you mean by 12 volts?	132
6.9 Combinations of projection setups	83	8.10 Polar alignment accuracy	133
6.10 Diffraction-limited resolution	84	8.11 Periodic gear error, PEC, and autoguiding	134
6.11 The subtle art of focusing	85	8.12 Choice of film	135
6.12 Camera viewfinders	86	8.13 Light pollution and nebula filters	137
6.13 PRACTICAL NOTE: Does your SLR focus accurately?	88	8.14 PRACTICAL NOTE: The campaign against light pollution	139
6.14 Aerial-image and crosshair focusing	89	8.15 Deep-sky photography through the telescope	142
6.15 Knife-edge focusing	89	8.16 BASIC TECHNIQUE 15: Deep-sky photography with an off-axis guider	144
6.16 How accurately must we focus?	90	8.17 Keeping warm while observing	145
6.17 Focusing Schmidt–Cassegrains and Maksutovs	91	8.18 Safety and etiquette at the observing site	145
		8.19 Mosquitoes and other vermin	146
7 The solar system	93	III PHOTOGRAPHIC TECHNOLOGY	149
7.1 Film or CCD?	93	9 Cameras, lenses, and telescopes	151
7.2 The challenge of high resolution	93	9.1 The 35-mm SLR	151
7.3 Tracking	94	9.2 Choosing an SLR	152
7.4 Vibration	96	9.3 Olympus SLRs	154
7.5 Unsteady air	97	9.4 Nikon SLRs	155
7.6 Dew	98	9.5 Other SLR makers	156
7.7 The sun	100	9.6 Buying used cameras	157
7.8 The moon	103		
7.9 Planetary photography	106		
7.10 The individual planets	107		
7.11 BASIC TECHNIQUE 11: Photographing a planet (afocal method)	111		
7.12 BASIC TECHNIQUE 12: Photographing a planet (by projection)	112		

Cambridge University Press

978-0-521-64133-3 - Astrophotography for the Amateur, Second Edition

Michael A. Covington

Table of Contents

[More information](#)

Contents ix

9.7	Camera maintenance and repair	158	11.4	PRACTICAL NOTE: Color negatives on black-and-white paper?	203
9.8	Some miscellaneous SLR hints	159	11.5	Making high-contrast prints	204
9.9	Other types of cameras	160	11.6	Unsharp masking	205
9.10	Special astrocameras	161	11.7	Processing color film	206
9.11	Lenses	162	11.8	PRACTICAL NOTE: Help! The film is scratched!	207
9.12	Lens quality and performance	164	11.9	Slide duplication	207
9.13	Lens mounts	165	11.10	Rephotography	210
9.14	Buying lenses	166			
9.15	BASIC TECHNIQUE 16: Testing lenses	167			
9.16	Lens repair	169			
9.17	Choosing a telescope	169			
9.18	PRACTICAL NOTE: Does a lower f-ratio give a brighter image?	170	IV DIGITAL IMAGING		213
9.19	Telescope quality and performance	171			
9.20	BASIC TECHNIQUE 17: Star-testing a telescope	171	12 Computer image enhancement		215
9.21	How to clean optics	172	12.1	How computers represent images	216
10 Film		174	12.2	Resolution and image size	218
10.1	How film works	174	12.3	PRACTICAL NOTE: How images get resized	220
10.2	Spectral sensitivity	175	12.4	File compression	220
10.3	The characteristic curve	177	12.5	File formats	222
10.4	Film speed	179	12.6	Getting images into the computer	222
10.5	Reciprocity failure: theory	180	12.7	Scanner artifacts	223
10.6	Reciprocity failure: measurement	181	12.8	PRACTICAL NOTE: Taking pictures that scan well	224
10.7	PRACTICAL NOTE: Does film "give up" after a certain amount of time?	184	12.9	The ethics of retouching	224
10.8	Hypersensitization	184	12.10	Manipulating the characteristic curve	225
10.9	Graininess and resolution	186	12.11	Working with histograms	229
10.10	Some specific films	187	12.12	Manipulating color	229
10.11	PRACTICAL NOTE: Film: What's in a name?	192	12.13	Enhancing detail	230
10.12	PRACTICAL NOTE: Is "professional" film better?	192	12.14	PRACTICAL NOTE: An example of digital enhancement	231
10.13	Bulk loading	193	12.15	Combining images	231
11 Developing, printing, and photographic enhancement		195	12.16	Printing out the results	231
11.1	The darkroom	195	12.17	Image enhancement theory: spatial frequency	232
11.2	Developing black-and-white film	196	12.18	PRACTICAL NOTE: Signal and noise	233
11.3	Black-and-white printing	201	12.19	Convolutions, 1: smoothing	233
			12.20	PRACTICAL NOTE: Median filters	236
			12.21	Convolutions, 2: sharpening	237
			12.22	The Laplacian operator	238

X CONTENTS

12.23	PRACTICAL NOTE: Convolution or deconvolution?	239	B.2	Declination drift	276
12.24	Maximum-entropy deconvolution	239	B.3	Field rotation	279
			B.4	Computer algorithms	281
13	CCD imaging	241	C	Plans for an electronic drive corrector	283
13.1	How CCDs work	242	C.1	How it works	283
13.2	Video and digital cameras	243	C.2	Circuits and parts list	286
13.3	Astronomical CCD cameras	244	C.3	Adaptation to 240 V, 50 Hz	287
13.4	Field of view	244	C.4	Drive rates	288
13.5	Aiming and focusing	246	C.5	Line power supply	288
13.6	Exposure	247	C.6	Other designs	289
13.7	Optimal focal length	248			
13.8	BASIC TECHNIQUE 18: Imaging the moon or a planet	249	D	Film data	290
13.9	Flat-fielding	250	D.1	Kodak Technical Pan film (TP)	291
13.10	Calibration frames	251	D.2	Kodak Professional Ektachrome Film E200	298
13.11	Deep-sky work	253	D.3	Kodak Professional Ektapress Films	306
13.12	Choosing a CCD camera	253			
			E	Photographic filters	307
APPENDICES	257		E.1	High-efficiency yellow, oranges, and reds	307
A	Exposure tables		E.2	Other sharp-cutoff filters	308
A.1	How exposures are calculated	259	E.3	Color balancing filters	309
A.2	Obtaining <i>B</i> from photometric brightness	259	E.4	Other filters	310
A.3	Other systems for calculating exposure	260	F	Organizations and resources	311
A.4	PRACTICAL NOTE: Why don't my results agree with the tables?	260	F.1	Organizations	311
A.5	Moon and lunar eclipses	261	F.2	Internet resources	312
A.6	Sun and solar eclipses	266	F.3	Magazines	312
A.7	Planets	269	F.4	Manufacturers	313
A.8	Faint objects	273	F.5	Dealers	315
B	Mathematical analysis of polar-axis misalignment	276	F.6	Camera repairs and modifications	317
B.1	Summary of the most important results	276			
				<i>Bibliography</i>	318
				<i>Index</i>	325
				<i>Colour plates</i>	facing p. 114