

# Contents

## **1 Recent Advances in Understanding Star and Planet Formation**

<i>I.N. Reid, S.L. Hawley</i> .....	1
1.1 Introduction .....	1
1.2 Star Formation .....	1
1.3 Planet Formation .....	8
1.4 Summary .....	16
References .....	17

## **2 Exoplanets and Their Properties**

<i>H.R.A. Jones</i> .....	21
2.1 Introduction .....	21
2.2 Finding Exoplanets .....	22
2.3 Properties of Exoplanets .....	28
2.4 The Future of Planet Searches .....	42
References .....	43

## **3 What Drives the Evolution of Close Binary Stars? The Test Case of Cataclysmic Variables**

<i>C. Hellier</i> .....	47
3.1 Introduction: The Need for Magnetic Braking .....	47
3.2 Discussion .....	57
References .....	59

## **4 The Cosmic Distance Scale**

<i>S. Webb</i> .....	61
4.1 Introduction .....	61
4.2 The Cosmological Distance Ladder .....	63
4.3 Geometrical Methods .....	73
4.4 Two Distance-Scale Puzzles .....	76
4.5 Future Developments .....	80
References .....	81

**5 The Cosmic Microwave Background**

<i>A.H. Jaffe</i> .....	89
5.1 Introduction.....	89
5.2 The CMB and the Physics of the Early Universe .....	94
5.3 CMB Experiments and CMB Data .....	102
5.4 Current Observations of the CMB.....	103
5.5 Summary .....	105
References .....	107

**6 Particle Astrophysics and the Dark Sector of the Universe**

<i>L. Bergström and A. Goobar</i> .....	111
6.1 Introduction.....	111
6.2 Cosmological Parameters from ‘Standard Candles’ .....	113
6.3 Current Results.....	114
6.4 Cross-Cutting Measurements .....	114
6.5 How Much Better Can We Do? .....	116
6.6 The Highest Redshift Supernova: SN1997ff .....	117
6.7 The Next Generation of SN Experiments.....	119
6.8 The Quintessence Alternative.....	119
6.9 The Nature of Dark Matter .....	123
6.10 More on the Dark Matter .....	124
6.11 Dark Matter Candidates .....	125
6.12 Indirect Detection Through Gamma-Rays .....	127
6.13 Non-Supersymmetric Candidates.....	130
6.14 Fluxes of Neutrinos in Standard Models .....	132
6.15 Particles Above the GZK Cutoff? .....	133
6.16 Summary and Conclusions .....	133
References .....	134

**7 The Early Universe: From Recombination to Reionization**

<i>W.C. Keel</i> .....	139
7.1 Introduction.....	139
7.2 Reionization.....	140
7.3 The First Stars .....	144
7.4 Where Do Black Holes Come From? .....	147
7.5 Prospects .....	150
References .....	151

**8 The Most Distant Galaxies**

<i>H. Spinrad</i> .....	155
8.1 Introduction, Motivations and Questions .....	155
8.2 Some Issues in the Contemporary Theory of Early Galaxy Evolution .....	158
8.3 A Race for the Maximum Redshift .....	160

8.4	The Identification of Very Distant Galaxies . . . . .	160
8.5	The Future . . . . .	176
	References . . . . .	177

## 9 Optical Spectroscopy Today and Tomorrow

<i>F. Watson</i> . . . . .	181	
9.1	Introduction . . . . .	181
9.2	Multi-Object Spectroscopy – Overview . . . . .	184
9.3	Multi-Object Spectroscopy with Robots . . . . .	190
9.4	Integral-Field Spectroscopy . . . . .	195
9.5	Efficiency by Design . . . . .	198
9.6	Future Challenges in Optical Spectroscopy . . . . .	202
	References . . . . .	204

## 10 Large-Scale Structures in the Distribution of Galaxies: The 2dF and Sloan Surveys

<i>A.P. Fairall</i> . . . . .	211	
10.1	Introduction . . . . .	211
10.2	Target Galaxies . . . . .	213
10.3	The Sloan Photometric Camera . . . . .	213
10.4	Sky Coverage . . . . .	214
10.5	Spectroscopy . . . . .	215
10.6	Redshift Maps and Large-Scale Structures . . . . .	217
10.7	Galaxy Properties and Spatial Distribution . . . . .	219
10.8	Clusters . . . . .	221
10.9	Redshift Space Distortion, Biasing and the Mass Density of the Universe . . . . .	222
10.10	Power Spectra . . . . .	223
10.11	$\Lambda$ Cosmology . . . . .	226
10.12	Concluding Remarks . . . . .	227
	References . . . . .	227

## 11 Active Galactic Nuclei and Supermassive Black Holes

<i>I. Robson</i> . . . . .	231	
11.1	Introduction and the Big Picture . . . . .	231
11.2	The Evidence for Supermassive Black Holes . . . . .	235
11.3	Black Holes and the Relation to the AGN . . . . .	240
11.4	AGN Evolution and Black Hole Growth . . . . .	244
11.5	The Central Engine and Accretion Disks . . . . .	248
11.6	Conclusions . . . . .	251
	References . . . . .	252

**12 The Story of Gamma-Ray Bursts**

<i>G. Vedrenne and J.-L. Atteia</i> .....	255
12.1 Introduction .....	255
12.2 The Early Times .....	256
12.3 CGRO: A New Step in Understanding the Origin of GRBs .....	264
12.4 BeppoSAX: Its Decisive Role in Understanding GRBs .....	267
12.5 A New Window on Stellar Explosions and on the Early Universe .....	270
12.6 The Story Continues.....	276
References .....	277

**13 Update on Gravitational Wave Research**

<i>L.P. Grishchuk</i> .....	281
13.1 Introduction .....	281
13.2 Elementary Theory of Gravitational Waves .....	282
13.3 Current Status of Gravitational-Wave Detectors .....	287
13.4 Gravitational Waves and Astrophysics .....	291
13.5 Gravitational Waves and Cosmology .....	296
13.6 Summary .....	306
13.7 Acknowledgements .....	307
References .....	307

<b>Index</b> .....	311
--------------------	-----