

CONTENTS

FOREWORD

vii

PRIMORDIAL NUCLEOSYNTHESIS

J. Audouze

1. Introduction	2
2. The Primordial Abundances of D, ^3He , ^4He and ^7Li	3
2.1 Deuterium (D)	3
2.2 Helium 3 (^3He)	4
2.3 Helium 4 (^4He)	4
2.4 Lithium 7 (^7Li)	5
2.5 The adopted primordial abundances of D, ^3He , ^4He and ^7Li	5
3. The Standard Big Bang Nucleosynthesis and Its Implications	6
3.1 The main characteristics of the standard Big Bang model	6
3.2 The early nucleosynthesis in the canonical Big Bang model	8
3.3 Chemical evolution of D and ^3He and primordial nucleosynthesis	12
4. Departures from Standard Big Bang Nucleosynthesis	16
4.1 Early nucleosynthesis in presence of quark nuggets	19
4.2 Early nucleosynthesis in presence of elementary particles decaying into energetic photons	20
4.3 Pregalactic formation of the very light elements	31
5. Conclusion	31
References	33

THE LARGE-SCALE STRUCTURE OF THE UNIVERSE

J. Silk

1.	Introduction	36
2.	Classical Cosmology	36
2.1	The expansion of the universe	36
2.2	Primordial nucleosynthesis	39
2.3	The cosmic blackbody radiation	39
3.	Particle Physics Cosmology	39
4.	Dark Matter	42
4.1	Astronomical determinations	42
4.2	Particle physics candidates	44
5.	Large-Scale Structure	47
5.1	Galaxy correlations	47
5.2	Peculiar velocities	47
5.3	Cluster correlations	48
5.4	Hubble bubbles	49
5.5	Large-scale streaming motions	50
6.	Origin of Large Scale Structure	52
6.1	Hot and cold dark matter	53
6.2	Biasing	54
6.3	Cosmic blackbody radiation isotropy	56
6.4	Confrontation with observations	59
6.5	Pancakes, strings and explosions	60
7.	Galaxy Formation	62
8.	Conclusions	67
	References	70

TOWARD THE INFLATIONARY PARADIGM:
LECTURES ON INFLATIONARY COSMOLOGY

M. Turner

1.	Overview	77
2.	The Standard Cosmology and Its Successes	80
3.	Shortcomings of the Standard Cosmology	86
4.	New Inflation – The Slow-Rollover Transition	93
5.	Scalar Field Dynamics	98
6.	Origin of Density Inhomogeneities	106
7.	Specific Models – Part I. Interesting Failures	112
7.1	“Old inflation”	112
7.2	Coleman-Weinberg SU(5)	113
7.3	Geometric hierarchy model	114
7.4	CERN SUSY/SUGR models	116
8.	Lessons Learned – A Prescription for Successful New Inflation	116
9.	Two Simple Models that Work	122
10.	Toward the Inflationary Paradigm	124
10.1	Chaotic inflation	125
10.2	Induced gravity inflation	126
10.3	The compactification transition	127
11.	Loose Ends	128
12.	Inflation Confronts Observation	131
13.	Epilogue	135
	References	136

THE AXION COUPLINGS

P. Sikivie

1. Introduction	144
2. The Axion Decay Constant	144
3. The Coupling of the Axion to Quarks and Leptons	149
4. The Low Energy Effective Theory of the Axion and the Pions	152
5. The Electromagnetic Coupling of the Axion	163
6. The Coupling of the Axion to Nucleons	165
7. Higher Order Effects	167
References	168

COSMIC STRINGS

T. W. B. Kibble

1. Introduction	171
2. Abelian Strings	172
3. Global Strings	173
4. Non-Abelian Strings	174
5. Other Topological Defects	176
6. Models with Strings	177
7. Composite Structures	178
8. Superconducting Strings	180

9.	Dynamics of Loops	181
10.	The Early Universe	184
11.	Phase Transitions in the Early Universe	186
12.	Initial Configuration of Strings	188
13.	Evolution of the String Configuration	190
14.	The Scaling Solution	192
15.	Distribution of Loops	194
16.	Gravitational Radiation	195
17.	Gravitational Field of a String	196
18.	Galaxy Formation	198
19.	Fluctuations at Decoupling	200
20.	Strings and Galaxy Formation	202
21.	Conclusions	205
	References	206

STRING THEORY AND QUANTUM COSMOLOGY

F. Englert

A.	The Bosonic String	210
1.	Introduction	210
2.	Torus compactification	212
3.	Space-time fermions and supersymmetry	216
	References	225

B. Quantum Cosmology	227
1. Introduction	227
2. The inflationary era	229
3. The Planckian era and the disappearance of time	233
4. The original event	236
References	240

COSMOLOGY AND EXTRA DIMENSIONS

E. W. Kolb

1. Microphysics in Extra Dimensions	243
2. Stability of the Internal Space	247
3. Semiclassical Instability of Compactification	264
4. Inflation and Extra Dimensions	265
5. Limiting Temperature in Superstring Models	272
6. GUT Symmetry Breaking in Extra Dimensions	274
7. Remnants	275
References	279
LIST OF PARTICIPANTS AND SPEAKERS	281

