

Contents

1	Prologue	1
	Introduction	1
	The urge to predict and control	3
	The paradox of predictability	5
	The external world: a first approximation	6
	Description or prescription?	8
	The different views of science	10
	Pros and cons	12
	Labels	19
	Accidental, legal, and statistical laws	21
	Intelligibility	24
2	Time past	27
	Primitive beginnings	27
	Social and religious precursors	31
	Chinese science	35
	The Greeks	38
	Plato	44
	Aristotle	48
	Aristotle's laws of motion	53
	The Aristotelian legacy	55
	Laws and rules of Nature	58
	Newton, the Newtonians, and Newtonianism	60
	The rationality of the world	77
	Darwinian laws	83
3	Unseen worlds	86
	Mechanism without a mechanism	86
	Force fields	87
	Electricity and magnetism	89
	The Sandemanian world-view	94
	The end of visualization?	96
	Mathematical modelling	97
	Space and time intertwine	99
	Curved space-time	105

Invariance	111
Symmetry	114
The laws of chance	116
Thermodynamics	122
Untidy desks	125
Demons at work	127
The eternal return	130
Quantum laws: Nature East of Eden	131
Schizophrenic matter	132
Intrinsic uncertainty	137
Waves of chance	141
The nature of quantum reality	144
The 'EPR paradox'	145
That crazy mixed-up cat	151
Quantum ailurophobia	152
How many worlds do we need?	154
The quantum legislature	157
4 Inner space and outer space	160
Setting the scene	160
A world within the world	162
Dissecting the atom	170
Brave new world	172
Incestuous matter?	174
Quarks	175
Quantum fields	177
The fundamental legislation of inner space	179
Unification	184
A new dimension	190
Why are there three dimensions of space?	191
What are the ultimate building blocks of matter?	193
The inner space 'credo'	197
Outer space	199
Unique aspects of cosmology	201
The goals of theory	209
The legacy of the steady statesmen	211
Chaotic cosmology	214
Inflation	217
The inflationary 'paradigm'	220
The future	222
Creation out of nothing?	226
Cosmology and the law	233

	The nature of time	234
	Where have all the dimensions gone?	236
5	Why are the laws of Nature mathematical?	238
	A puzzle	238
	What is mathematics?	240
	A shock for the formalists	254
	Consequences for physical science	257
	What is truth?	260
	Computability	262
	Inherently difficult problems	265
	The dilemma of ignorance	271
	Maxwell on determinism	271
	Chaos	277
	Equations	279
	Law without law	281
	Are the laws of Nature computable?	289
	The cosmic code—a final speculation	291
6	Are there any laws of Nature?	293
	Heretical notions	293
	Between a rock and a hard place	295
	Too many laws?	299
	Spontaneous order	300
	Does life transcend the laws of Nature?	303
	Accidental symmetries	305
	Places where the laws of Nature break down	306
	Black hole ontogenesis	310
	Cosmic censorship	313
	Can we probe a singularity?	316
	Staccato time	317
	Constants of Nature	321
	Weights and measures	324
	Varying constants	326
	A window onto extra dimensions?	328
7	Selection effects	330
	Patterns in the trees	331
	The phantoms of the laboratory	336
	Errors	339
	The ‘Groucho Marx Effect’	342

Beauty	345
The Anthropic Principle	352
Coincidences	357
The speculative Anthropic Principle	359
Life and observership	360
Is the Anthropic Principle an argument for the existence of God?	363
The time of your life	366
The misanthropists	368
Select Bibliography	374
Index	387