TABLE OF CONTENTS

FOREWORD: Science and Change by Alvin Toffler xi

PREFACE: Man's New Dialogue with Nature xxvii

INTRODUCTION: The Challenge to Science 1

Book One: The Delusion of the Universal

CHAPTER I: The Triumph of Reason 27

1. The New Moses 27
2. A Dehumanized World 30
3. The Newtonian Synthesis 37
4. The Experimental Dialogue 41
5. The Myth at the Origin of Science 44
6. The Limits of Classical Science 51

CHAPTER II: The Identification of the Real 57

1. Newton's Laws 57
2. Motion and Change 62
3. The Language of Dynamics 68
4. Laplace's Demon 75

CHAPTER III: The Two Cultures 79

1. Diderot and the Discourse of the Living 79
2. Kant's Critical Ratification 86
3. A Philosophy of Nature? Hegel and Bergson 89
4. Process and Reality: Whitehead 93
5. "Ignoramus, Ignoramibus": The Positivist's Strain 96
6. A New Start 98

Book Two: The Science of Complexity

CHAPTER IV: Energy and the Industrial Age 103

1. Heat, the Rival of Gravitation 103
2. The Principle of the Conservation of Energy 107
3. Heat Engines and the Arrow of Time 111
4. From Technology to Cosmology 115
5. The Birth of Entropy 117
6. Boltzmann's Order Principle 122
7. Carnot and Darwin 127

CHAPTER V: The Three Stages of Thermodynamics 131

1. Flux and Force 131
2. Linear Thermodynamics 137
3. Far from Equilibrium 140
4. Beyond the Threshold of Chemical Instability 146
5. The Encounter with Molecular Biology 153
6. Bifurcations and Symmetry-Breaking 160
7. Cascading Bifurcations and the Transitions to Chaos 167
8. From Euclid to Aristotle 171

CHAPTER VI: Order Through Fluctuations 177

1. Fluctuations and Chemistry 177
2. Fluctuations and Correlations 179
3. The Amplification of Fluctuations 181
4. Structural Stability 189
5. Logistic Evolution 192
6. Evolutionary Feedback 196
7. Modelizations of Complexity 203
8. An Open World 207

Book Three: From Being to Becoming

CHAPTER VII: Rediscovering Time 213

1. A Change of Emphasis 213
2. The End of Universality 217
3. The Rise of Quantum Mechanics 218
4. Heisenberg's Uncertainty Relation 222
5. The Temporal Evolution of Quantum Systems 226
6. A Nonequilibrium Universe 229

CHAPTER VIII: The Clash of Doctrines 233

1. Probability and Irreversibility 233
2. Boltzmann's Breakthrough 240
3. Questioning Boltzmann's Interpretation 243
4. Dynamics and Thermodynamics: Two Separate Worlds 247
5. Boltzmann and the Arrow of Time 253

CHAPTER IX: Irreversibility—the Entropy Barrier 257

1. Entropy and the Arrow of Time 257
2. Irreversibility as a Symmetry-Breaking Process 260
3. The Limits of Classical Concepts 261
4. The Renewal of Dynamics 264
5. From Randomness to Irreversibility 272
6. The Entropy Barrier 277
7. The Dynamics of Correlations 280
8. Entropy as a Selection Principle 285
9. Active Matter 286

CONCLUSIONS: From Earth to Heaven—
the Reenchantment of Nature 291

1. An Open Science 291
2. Time and Times 293
3. The Entropy Barrier 295
4. The Evolutionary Paradigm 297
5. Actors and Spectators 298
6. A Whirlwind in a Turbulent Nature 301
7. Beyond Tautology 305
8. The Creative Course of Time 307
9. The Human Condition 311
10. The Renewal of Nature 312

NOTES 315

INDEX 335