

Contents

1 • The View from Nowhen	3
Outline of the book · 5 Remarks on style · 11 The stock philosophical debates about time · 12 The arrows of time · 16 The puzzle of origins · 17	
2 • “More Apt to Be Lost than Got”: The Lessons of the Second Law	22
Irreversibility discovered: Newton to Boltzmann · 23 The reversibility objection I · 27 Entropy as probability · 29 The reversibility objection II · 31 Boltzmann’s symmetric view · 32 Do we need to explain why entropy increases? · 37 The role of the <i>H</i> -theorem · 40 Does chaos theory make a difference? · 43 Branch systems · 44 Could entropy eventually decrease? · 46 Summary · 47	
3 • New Light on the Arrow of Radiation	49
The circular wave argument · 54 Radiation and banking · 58 Radiation and nonfrictionless banking · 60 What would time-symmetric radiation look like? · 61 The Wheeler-Feynman theory in brief · 65 Why doesn’t the argument work in reverse? · 67 Are the components distinct? · 69 The new interpretation · 70 Why the apparent asymmetry? · 71 No need for a future absorber · 73 Related issues in physics · 73 Summary · 76	
4 • Arrows and Errors in Contemporary Cosmology	78
The need for smoothness · 79 Gold universes and the basic dilemma · 81 Smoothness: how surprising is it? · 82 The appeal to inflation · 85 Hawking and the big crunch · 86 The basic dilemma and some ways to avoid it · 93 What’s wrong with a Gold universe? · 99 A telescope to look into the future? · 105 Conclusion · 111	

5 • Innocence and Symmetry in Microphysics	114
Conflicting intuitions in contemporary physics • 116 Preinteractive “innocence”: the intuitive asymmetry • 118 Two kinds of innocence in physics • 120 Is μ Innocence observable? • 121 Symmetry or innocence? • 123 μ Innocence and quantum mechanics • 124 μ Innocence and backward causation • 127 The next step • 129	
6 • In Search of the Third Arrow	132
Causal asymmetry: the nature of the problem • 136 A third arrow? • 138 The fork asymmetry • 138 Too few forks • 140 Two ways to misuse a fork • 142 A fourth arrow? • 146 The symmetry of micro-forks • 147 Two extreme proposals • 152 The perspectival view • 155 Escaping a circle, projecting an arrow • 159 Summary • 161	
7 • Convention Objectified and the Past Unlocked	162
Asymmetry conventionalized • 163 Convention objectified • 166 The asymmetry of agency • 168 The role of counterfactuals • 169 Could the past depend on the future? • 170 Escaping the paradoxes of backward causation • 171 The past unlocked • 174 Advanced action: its objective core • 177 Counterfactuals: what should we fix? • 178 Advanced action and μ Innocence • 179 Is μ Innocence merely conventional? • 181 Why can't a photon be more like a billiard ball? • 183 Symmetry and advanced action I • 185 Symmetry and advanced action II • 187 Taxonomy and T-symmetry • 189 Backward causation: not forward causation backwards • 190 Inverted forks and distant effects • 191 Summary: saving the baby • 192	
8 • Einstein's Issue: The Puzzle of Contemporary Quantum Theory	195
The quantum view: basic elements • 197 A TOM SPLIT IN THOUGHT EXPERIMENT! • 198 The EPR argument • 201 EPR and special relativity: the cost of nonlocality • 204 The temporal asymmetry objection • 206 The consequences of superposition • 209 Bell's Theorem • 212 EPR for triplets: the GHZ argument • 217 What if there is no collapse? • 219 Many minds? • 222 The decoherence approach • 225 Summary: Einstein's live issue • 228	

9 • The Case for Advanced Action 231

Outline of the chapter · 233 Locality, independence, and
the pro-liberty Bell · 235 Locality saved in the past · 236
Locality saved in the future · 238 Was Bell told? · 241
The benefits of backward forks · 242 Advanced action
in quantum mechanics · 246 Einstein reissued? · 248
Advanced action and the GHZ argument · 251 Advanced
action and superposition · 252 The atemporal view · 257

10 • Overview 261

Main conclusions of the book · 262 Directions for
further work · 266 Why it matters · 266

NOTES 269

BIBLIOGRAPHY 285

INDEX 293