

# Contents

<i>Preface</i>	<i>page ix</i>
1 Introduction	1
2 Arguments from math	7
2.1 Outline	7
2.2 Zeno’s paradox of extension	9
2.3 Topology and the argument against collision	13
2.4 Geometry and the tile argument	20
2.5 Richer alternatives to the real line model	27
2.6 The physical Church–Turing thesis	31
2.7 Pure versus applied mathematics	35
3 Arguments from philosophy	37
3.1 Outline	37
3.2 Metaphysical motivations	39
3.3 Epistemology and the primacy of “length”	44
3.4 Is discreteness transcendental?	49
3.5 Enough with the “isms”	52
4 Electrodynamics, QED, and early QFT	54
4.1 Outline	54
4.2 Classical electrodynamics	56
4.3 From QM to QED	63
4.4 The rise of renormalization	83
4.5 Philosophical ramifications	88

5	Quantum gravity: prehistory	97
5.1	Outline	97
5.2	Early steps	98
5.3	Gravitons, measurability, and the Planck scale	107
5.4	Non-commutative geometry	112
5.5	(Re)enters gravity	118
5.6	Quantizing gravity – the philosophical debate	126
6	Einstein on the notion of length	141
6.1	Outline	141
6.2	Constructing the principles	142
6.3	The Swann–Einstein correspondence	149
6.4	Reading Einstein	156
6.5	Einstein and the constructive approach to STR	160
6.6	Geometry and dynamics, again	170
7	Quantum gravity: current approaches	171
7.1	Outline	171
7.2	String theory	174
7.3	Background independent strategies	181
7.4	Emergent gravity	193
7.5	On the “disappearance” of spacetime	194
8	The proof is in the pudding	201
8.1	Outline	201
8.2	The quest for quantum gravity phenomenology	203
8.3	Consistency proofs	208
8.4	The perils of innovation	213
8.5	There and back again	228
9	Coda	231
	<i>References</i>	239
	<i>Index</i>	264