

# Contents

<b>1</b>	<b>Pre-Quantum Theories . . . . .</b>	<b>1</b>
1.1	Newtonian Mechanics . . . . .	1
1.2	Maxwellian Electrodynamics . . . . .	5
1.3	Locality . . . . .	8
1.4	Bell's Formulation of "Locality" . . . . .	13
1.5	Ontology . . . . .	18
1.6	Measurement . . . . .	22
1.7	Abstract Spaces . . . . .	25
	References . . . . .	31
<b>2</b>	<b>Quantum Examples . . . . .</b>	<b>33</b>
2.1	Overview . . . . .	33
2.2	Particle-in-a-Box . . . . .	36
2.3	Free Particle Gaussian Wave Packets . . . . .	38
2.4	Diffraction and Interference . . . . .	44
2.5	Spin . . . . .	47
2.6	Several Particles . . . . .	51
	References . . . . .	57
<b>3</b>	<b>The Measurement Problem . . . . .</b>	<b>59</b>
3.1	The Quantum Description of Measurement . . . . .	59
3.2	Formal Treatment . . . . .	64
3.3	Schrödinger's Cat and Einstein's Bomb . . . . .	69
3.4	Hidden Variables and the Ignorance Interpretation . . . . .	74
3.5	Wrap-Up . . . . .	79
	References . . . . .	85
<b>4</b>	<b>The Locality Problem . . . . .</b>	<b>87</b>
4.1	Einstein's Boxes . . . . .	87
4.2	EPR . . . . .	96
4.3	Einstein's Discussions of EPR . . . . .	100

4.4	Bohm's Reformulation . . . . .	104
4.5	Bell's Re-Telling . . . . .	107
	References . . . . .	113
<b>5</b>	<b>The Ontology Problem . . . . .</b>	<b>115</b>
5.1	Complexity and Reality . . . . .	115
5.2	Configuration Space . . . . .	118
5.3	Ontology, Measurement, and Locality . . . . .	122
5.4	Schrödinger's Suggestion for a Density in 3-Space . . . . .	129
5.5	So Then What? . . . . .	133
	References . . . . .	139
<b>6</b>	<b>The Copenhagen Interpretation . . . . .</b>	<b>141</b>
6.1	Bohr's Como Lecture . . . . .	142
6.2	Heisenberg . . . . .	148
6.3	Bohr on Einstein's Diffraction Example . . . . .	154
6.4	The Photon Box Thought Experiment . . . . .	160
6.5	Bohr's Reply to EPR . . . . .	166
6.6	Contemporary Perspectives . . . . .	169
	References . . . . .	174
<b>7</b>	<b>The Pilot-Wave Theory . . . . .</b>	<b>177</b>
7.1	Overview . . . . .	178
7.2	Particle in a Box . . . . .	182
7.3	Other Single Particle Examples . . . . .	185
7.4	Measurement . . . . .	188
7.5	Contextuality . . . . .	194
7.6	The Many-Particle Theory and Nonlocality . . . . .	199
7.7	Reactions . . . . .	205
	References . . . . .	212
<b>8</b>	<b>Bell's Theorem . . . . .</b>	<b>215</b>
8.1	EPRB Revisited . . . . .	215
8.2	A Preliminary Bell Inequality . . . . .	218
8.3	The Real Bell (and the CHSH) Inequality . . . . .	222
8.4	Experiments . . . . .	227
8.5	What Does It Mean? . . . . .	231
8.6	(Bell's) Locality Inequality Theorem . . . . .	236
	References . . . . .	243
<b>9</b>	<b>The Spontaneous Collapse Theory . . . . .</b>	<b>245</b>
9.1	Ghirardi, Rimini, and Weber . . . . .	246
9.2	Multiple Particle Systems and Measurement . . . . .	254
9.3	Ontology, Locality, and Relativity . . . . .	259
9.4	Empirical Tests of GRW . . . . .	265
	References . . . . .	271

<b>10 The Many-Worlds Theory . . . . .</b>	273
10.1 The Basic Idea . . . . .	274
10.2 Probability . . . . .	280
10.3 Ontology . . . . .	286
10.4 Locality . . . . .	291
References . . . . .	302
<b>Afterword . . . . .</b>	303