Contents

1 Pre-Quantum Theories 1
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

2 Quantum Examples 33
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

3 The Measurement Problem 59
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

4 The Locality Problem 87
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

5 The Ontology Problem . . . 115
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

6 The Copenhagen Interpretation . . . 141
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

7 The Pilot-Wave Theory . . . 177
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

8 Bell's Theorem . . . 215
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

9 The Spontaneous Collapse Theory . . . 245
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

10 The Many-Worlds Theory 273
10.1 The Basic Idea 274
10.2 Probability 280
10.3 Ontology 286
10.4 Locality 291
References 302

Afterword 303

http://www.springer.com/978-3-319-65866-7

Foundations of Quantum Mechanics
An Exploration of the Physical Meaning of Quantum Theory
Norsen, T.
2017, XV, 310 p. 70 illus., 12 illus. in color., Softcover
ISBN: 978-3-319-65866-7