

Mendel Sachs

QUANTUM MECHANICS AND GRAVITY



Springer

Contents

1. Introduction	1
1.1 History and Philosophy of the Quantum Theory.....	2
1.1.1 Blackbody Radiation	2
1.1.2 Photoelectric Effect	3
1.1.3 Compton Effect	4
1.1.4 Atomic Spectra and the Bohr Atom	4
1.1.5 The Seminal Experiment: Electron Diffraction ...	6
1.1.6 Interpretations of Quantum Mechanics	9
1.2 History and Philosophy of Theories of Gravity	
Leading to the Theory of General Relativity	11
1.2.1 Newton's Third Law of Motion	15
1.2.2 Predictions of Einstein's Theory of General Relativity	18
1.3 A Quantum Theory of Gravity	21
2. The Theory of General Relativity:	
Einstein's Formulation	25
2.1 The Spacetime Language.....	26
2.2 On Invariance of the Speed of Light	27
2.3 The Riemannian Metric	28
2.4 Expression of Einstein's Field Equations	30
2.5 Einstein's Equations from the Variational Principle ..	31
2.6 The Vacuum Equation	34
2.7 The Geodesic Equation	36
2.8 The Schwarzschild Solution and the Newtonian Limit ..	39
3. A Unified Field Theory	43
3.1 Einstein's Field Theory in Quaternion Form	44
3.2 Spin Affine Connection	47
3.3 The Quaternion Variables in a Riemannian Spacetime .	48

XII Contents

3.4	Derivation of the Quaternion Metrical Field Equations from the Principle of Least Action	50
3.5	A Symmetric Tensor–Antisymmetric Tensor Representation of General Relativity	53
3.5.1	Einstein’s Field Equation from the Symmetric Tensor Part	54
3.5.2	The Maxwell Field Equations from the Antisymmetric Part	55
3.6	The Geodesic Equation in Quaternion Form	58
3.7	Summary	61
4.	Quantum Mechanics from a Theory of Inertial Mass in Relativity	63
4.1	Introduction	64
4.2	Discovery of Quantum Mechanics	67
4.3	Inertial Mass from General Relativity	71
4.4	The Matter Field Equations in General Relativity	73
4.5	Gauge Covariance	73
4.6	The Elementary Interaction	75
4.7	Proof of the Attractive Gravitational Force in the Newtonian Limit and the Oscillating Universe Cosmology	76
4.8	From the Mach Principle to the Generalized Mach Principle	77
5.	Electromagnetism	79
5.1	Introduction	80
5.2	Interpretation of Maxwell’s Equations in the Holistic Field Theory	83
5.3	The Elementary Interaction Formulation	84
5.4	A Spinor Formulation of Electromagnetic Theory in Special Relativity	85
5.5	Invariants and Conservation Equations in the Spinor Formalism	86
5.6	Lagrangian for the Spinor Formulation of Electromagnetism	88
5.7	Faraday’s Approach and the Mach Principle	90
5.8	Spinor Formulation of Electromagnetism in General Relativity	90
5.9	Extension of the Spinor Conservation Laws of Electromagnetism in General Relativity	91

5.10 The Electromagnetic Interaction Functional in the Matter Field Equations	94
5.11 Delayed Action at a Distance	95
6. The Pauli Principle and Pair Creation/Annihilation	97
6.1 Introduction	98
6.2 The Individual Particle Model	100
6.3 The Free Field Limit	100
6.4 Conservation of Interaction	101
6.5 The Pauli Exclusion Principle.....	103
6.6 Sufficiency of the Three Conditions for Proof of the Pauli Principle	108
6.7 Fermi–Dirac Statistics from the Nonrelativistic Approximation for Ψ	110
6.8 Bound Particle–Antiparticle Pairs. Ground State	111
6.9 Energy and Momentum of the Bound Pair in its Ground State	113
6.10 Dynamical Properties of the Pair in its Ground State ..	114
6.11 Pair Creation, the Physical Vacuum, and Blackbody Radiation	117
7. Atomic and Elementary Particle Physics	121
7.1 Introduction	122
7.2 Hydrogen	124
7.2.1 Linearization of the Hydrogen Field Equation ..	124
7.2.2 The Lamb Splitting	127
7.3 The Neutron	130
7.3.1 Binding Energy of the Neutron: A Phenomenological Determination	131
7.3.2 The Neutron Lifetime	132
7.3.3 The Neutron Magnetic Moment	134
7.4 Mass Doublets: The Electron–Muon	135
7.5 Infinite Lepton Spectrum.....	136
7.6 The Pion	138
7.6.1 Ratio of Neutral and Charged Pion Masses	139
7.6.2 Ratio of Neutral and Charged Pion Lifetimes....	140
7.7 CP Violation in Neutral Kaon Decay	141
7.8 Charge Quantization in General Relativity	143

8. Astrophysics and Cosmology in General Relativity	147
8.1 Introduction	148
8.2 Principle of Equivalence	150
8.3 The Quaternion Geodesic for a Stationary Orbit	152
8.4 Planetary Motion	153
8.5 The Schwarzschild Problem	155
8.6 The Radial Solution and Perihelion Precession	158
8.7 The Hubble Law and Cosmology	159
8.7.1 The Oscillating Universe Cosmology	160
8.7.2 Dynamics of the Expansion and Contraction of the Universe	161
8.7.3 Spiral Structure of the Universe	163
8.8 Black Holes and Pulsars	166
8.8.1 Possible Model of a Pulsar	168
8.8.2 Damped Oscillatory Motion and Pulsars	170
8.9 Separation of Matter and Antimatter in the Early Universe	171
Bibliography	175
Index	189