Contents

Foreword xiii
Preface xvii
Acknowledgements xxi

1. THE CAUSAL ENIGMA 1
1.1 Microcosm—is it causal or bitemporal? 1
1.2 The neoclassical electromagnetic theory 5
1.3 Causal theories—incomplete in microcosm 7

2. PHOTONS IN BITEMPORAL MICROCOSM 11
2.1 Introduction 11
2.2 Plane photon pulses in the bitemporal time domain 16
2.2.1 Classical photon pulses in the regular time domain 17
2.2.2 Photons in the negative time domain–parity reversal 17
2.2.3 Generalization of photon pulse energy 21
2.2.4 The role of antiphotons in the matching process 22
2.3 The photon routing process 23
2.4 Photon doublets—the new entities 27
2.4.1 Spatially localized photon doublets 29
2.4.2 Entangled photon doublets 33
2.4.3 The CPT theorem for photon doublets 33
2.5 Concluding remarks 35

3. NEOCLASSICAL ELECTROMAGNETICS 39
3.1 Definition of the generalized circuit 39
3.2 Generalized circuit equation 42
3.2.1 Virtual terminals of the generalized circuit 44
3.2.2 Stored energy in the generalized circuit 44
3.2.3 Stored energy at positive frequencies 45
3.2.4 Stored energy at negative frequencies 49
3.3 General definition of photon doublets 51
3.3.1 Stored energy of doublets 52
3.3.2 Photon doublet resonances 54

3.3.3 Doublet resonances—spontaneous excitation? 56
3.3.4 Doublet spectral energy density 58
3.3.5 Quantum mechanical ZPE fluctuations 61
3.4 The scattering formulation of circuit response 64
3.4.1 Stored energy in the scattering formulation 65
3.4.2 Scattering relations for negative frequencies 66
3.4.3 Doublet scattering relations and resonances 67

APPENDIX TO CHAPTER 3 68
A.1 Field Equations 68
A.2 Reciprocity Formulations for the Generalized Circuit 69
A.2.1 Generalized admittance matrix 71
A.2.2 Generalized voltage and current representation 72
A.2.3 Transformation of the circuit to different bases 73

4. ARE ELECTRON MEDIA BITEMPORAL? 75
4.1 Doublet interactions in collisionless plasmas 75
4.1.1 Plasma response to general photon doublets 76
4.1.2 Plasma response to electric and magnetic doublets 79
4.2 Bitemporal collision scattering in conductors 80
4.2.1 Bitemporal scattering parameters 82
4.2.2 Scatter dominated regime 83
4.3 Bitemporal DC conduction in a circular wire 86
4.3.1 The symmetric conduction mode 86
4.3.2 Dual states of the symmetric mode 89
4.3.3 Regular conducting state 90
4.3.4 Lossless conducting state 91
4.3.5 The antisymmetric conduction modes 93
4.3.6 Comparison with the BCS superconducting theory 95

5. PHOTON WAVE–PARTICLE TRANSITION 99
5.1 Introduction—the paradox 99
5.1.1 Neoclassical theory of photon transition 100
5.2 Classical time average macroscopic transition 103
5.3 Wave to particle transition of single photons 105
5.3.1 Verification of zero time average doublet admixture 107
5.4 Photon emission and absorption by atoms 110
5.5 Photon wave to particle transition in striplines 114
5.5.1 Evanescent doublet supplements at the load 116
5.5.2 Complete photon reflection 119
5.5.3 Complete photon absorption 120
5.5.4 Lateral resolution of the particlelike photon beam 122
5.5.5 Numerical simulations of photon flow pattern 124
5.5.6 Verification of zero time average doublet admixture 125

6. PHOTONS IN GENERAL NETWORKS 129
6.1 Classical circuit modeling 129
6.2 Single photon predicament in general circuits 134

6.2.1 Quantum mechanical interpretation 135
6.2.2 Classical electromagnetics—at a loss 136
6.3 Neoclassical theory of single photons in networks 137
6.3.1 Routing of photons in the network 140
6.3.2 Concept of independent network terminals 145
6.3.3 Microscopic causality gone 147

7. DOUBLE SLIT EXPERIMENT FOR PHOTONS 151
7.1 Introduction—the paradoxes 151
7.1.1 Neoclassical interpretation 152
7.2 Classical macroscopic model 155
7.2.1 Slit plate scattering of space harmonics 155
7.2.2 Macroscopic transmission and reflection 158
7.2.3 Macrophotons—a macroscopic concept 160
7.2.4 Numerical simulations of macrophoton power flux 162
7.3 Neoclassical theory of single photon routing 165
7.3.1 General criteria for single photon transmission 166
7.3.2 General criteria for single photon reflection 168
7.3.3 Transmission of photons to local screen spots 169
7.3.4 Numerical simulations of transmitted photons 172
7.3.5 Reflection of photons at the slit plate 173
7.3.6 Numerical simulations of reflected single photons 174
7.3.7 Minimization of environmental energy fluctuations 175
7.3.8 Analysis of spot buildup of diffraction pattern 180
7.4 Numerical procedure of spot build up pattern 183

APPENDIX TO CHAPTER 7 185
A.1 Fields in the double slit plate system 185
A.1.1 A special adaptation of the field equations 186
A.1.2 Field solutions in the free space regions 190
A.1.3 Slit plate convolution matrix 191
A.1.4 Slit plate orthogonal eigenvectors 192
A.1.5 Separation of fields in the slit plate region 194
A.1.6 Open slit fields of the nullspace set U_0 197
A.1.7 Solid slit plate fields of the range set U_1 197
A.1.8 Slit plate boundary conditions 199
A.2 Slit plate scattering matrix 201
A.2.1 Symmetry properties of the slit plate 202
A.2.2 Scattering matrix for the overall configuration 203

8. DOUBLE SLIT EXPERIMENT FOR ELECTRONS 205
8.1 Introduction—the paradoxes 205
8.2 Electromagnetic fields of the double slit plate 209
8.2.1 Can single electrons excite the slit fields? 213
8.2.2 Discrete momentum levels of the slit plate 214
8.2.3 Deflection of electrons traversing the slits 218
8.2.4 Angular spread in the slits 220
8.3 Diffraction pattern with numerical simulations 225

8.3.1 Frauenhofer diffraction pattern 226
8.3.2 Quantum mechanical electron waves 229
8.4 Neoclassical theory of electron diffraction from a single slit 230

9. THE ENIGMATIC 1/F NOISE 233
9.1 What is 1/f noise? 233
9.2 Hooge's empirical 1/f hypothesis 234
9.3 Photon excitation of 1/f noise 235
9.3.1 The DC photon state–definition and interpretation 237
9.3.2 Behavior of single DC photon pulses 242
9.3.3 The radial transmission line–appropriate model 247
9.4 Macroscopic scattering in the radial resistor system 252
9.5 Single photon absorption and reflection at the resistor 254
9.5.1 Theoretical noise power spectrum 257
9.5.2 A theoretical 'Hooge' formula 259
9.5.3 A modified 'Hooge' formula 260
9.5.4 The 1/f noise phenomenon—more than just noise 261
9.6 Concluding remarks 262

10. QUESTIONING STERN-GERLACH 265
10.1 Basis of the Stern-Gerlach experiment 265
10.1.1 Standard description of the SG experiment 266
10.2 The flaw in the Stern-Gerlach theory 269
10.2.1 Multipole expansion of the magnetic field 271
10.2.2 Is the silver atom model adequate? 272
10.2.3 Numerical simulations of deposition pattern 274

11. PHOTON TUNNELING—SUPERLUMINAL? 277
11.1 Photon tunneling in a microwave configuration 277
11.1.1 Macroscopic 'tunneling' 280
11.1.2 Neoclassical theory of single photon tunneling 281
11.1.3 Superluminal tunneling 284

APPENDIX TO CHAPTER 11 285
A.1 Scattering matrix of the tunneling section 285

12. INTERFEROMETRIC EXPERIMENTS 289
12.1 Introduction 289
12.2 Neoclassical theory of the beam splitter 290
12.2.1 Macroscopic properties of the beam splitter 290
12.2.2 Single photons in the beam splitter 293
12.2.3 Quantum mechanical view 294
12.2.4 Neoclassical view 295
12.3 The Mach-Zehnder interferometer 297
12.3.1 Macroscopic response of the interferometer 299
12.3.2 Single photon response of the interferometer 299
12.3.3 Photon signal flow in the interferometer paths 301

12.4 Mach-Zehnder delayed choice experiment 303
12.4.1 Cosmic delayed choice experiments 311

13. THE FAMOUS EPR PARADOX 315
13.1 Introduction 315
13.2 The basic EPR configuration 316
13.2.1 Macroscopic properties of the polarizer 316
13.2.2 Single photons in the polarizer 318
13.2.3 Quantum theory of the polarizer 319
13.2.4 Neoclassical theory of the polarizer 319
13.3 Neoclassical theory of the EPR configuration 322
13.3.1 EPR with aligned polarizers 323
13.3.2 EPR with nonaligned polarizers 324
13.4 The EPR paradox in neoclassical interpretation 327
13.4.1 Bell's theorem in light of the neoclassical theory 330
13.4.2 The physics of nonlocal connections 331
13.4.3 The Aspect delayed choice EPR experiment 332

14. QUANTUM BASES–NEOCLASSICAL VIEW 337
14.1 Introduction 337
14.2 Quantum principles and 'foolish questions' 338
14.3 The uncertainty relation—how uncertain? 342
14.3.1 Heuristic derivation of the uncertainty relation 344
14.3.2 Heisenberg Microscope—uncertainty and duality 349
14.3.3 Electron diffraction in a slit 352
14.3.4 Neoclassical uncertainty—a different kind 354
14.4 Collapse of the wave function–the measurement problem 356
14.4.1 The measurement problem in quantum theory 358
14.4.2 Neoclassical view—the measurement problem gone 359

References 363
Index 367