

Contents

	<i>page</i>
<i>Preface</i>	<i>xi</i>
1 Introduction	1
2 Historical milestones	3
2.1 Light waves à la Huygens	3
2.2 Newton's light particles	5
2.3 Young's interference experiment	9
2.4 Einstein's hypothesis of light quanta	12
3 Basics of the classical description of light	17
3.1 The electromagnetic field and its energy	17
3.2 Intensity and interference	19
3.3 Emission of radiation	22
3.4 Spectral decomposition	24
4 Quantum mechanical understanding of light	29
4.1 Quantum mechanical uncertainty	29
4.2 Quantization of electromagnetic energy	33
4.3 Fluctuations of the electromagnetic field	38
4.4 Coherent states of the radiation field	39
5 Light detectors	41
5.1 Light absorption	41
5.2 Photoelectric detection of light	43
5.3 The photoeffect and the quantum nature of light	48
6 Spontaneous emission	59
6.1 Particle properties of radiation	59
6.2 The wave aspect	63
6.3 Paradoxes relating to the emission process	67
6.4 Complementarity	69
6.5 Quantum mechanical description	71
6.6 Quantum beats	77

viii	<i>Contents</i>	
	6.7 Parametric fluorescence	79
	6.8 Photons in “pure culture”	82
	6.9 Properties of photons	84
7	Interference	87
	7.1 Beamsplitting	87
	7.2 Self-interference of photons	91
	7.3 Delayed choice experiments	97
	7.4 Interference of independent photons	98
	7.5 Which way?	108
	7.6 Intensity correlations	117
	7.7 Photon deformation	123
8	Photon statistics	127
	8.1 Measuring the diameter of stars	127
	8.2 Photon bunching	134
	8.3 Random photon distribution	141
	8.4 Photon antibunching	145
9	Squeezed light	155
	9.1 Quadrature components of light	155
	9.2 Generation	157
	9.3 Homodyne detection	160
10	Measuring distribution functions	165
	10.1 The quantum phase of light	165
	10.2 Realistic phase measurement	166
	10.3 State reconstruction from measured data	174
11	Optical Einstein–Podolsky–Rosen experiments	177
	11.1 Polarization entangled photon pairs	177
	11.2 The Einstein–Podolsky–Rosen paradox	182
	11.3 Hidden variables theories	183
	11.4 Experimental results	190
	11.5 Faster-than-light information transmission?	193
	11.6 The Franson experiment	196
12	Quantum cryptography	201
	12.1 Fundamentals of cryptography	201
	12.2 Eavesdropping and quantum theory	202
13	Quantum teleportation	207
	13.1 Transmission of a polarization state	207
	13.2 Transmission of a single-mode wave function	211
14	Summarizing what we know about the photon	215
15	Appendix. Mathematical description	219
	15.1 Quantization of a single-mode field	219

Cambridge University Press

978-0-521-83563-3 - Introduction to Quantum Optics: From Light Quanta to Quantum Teleportation

Harry Paul

Table of Contents

[More information](#)

	<i>Contents</i>	ix
15.2	Definition and properties of coherent states	222
15.3	The Weisskopf–Wigner solution for spontaneous emission	226
15.4	Theory of beamsplitting and optical mixing	228
15.5	Quantum theory of interference	232
15.6	Theory of balanced homodyne detection	234
	<i>References</i>	235
	<i>Index</i>	240