

Preface — VII

1 Basics of electromagnetic waves — 1

- 1.1 Electromagnetism — 1
- 1.2 Electromagnetic waves — 3
- 1.3 Maxwell's equations — 5
 - 1.3.1 Energy transfer and Poynting vector — 6
 - 1.3.2 Maxwell's equations under boundary condition — 7
 - 1.3.3 Waveguide and waveguide modes — 8
 - 1.3.4 Rectangular waveguide — 11
- 1.4 Optical fiber and light propagation — 14
 - 1.4.1 EM-wave equation and its solution for an SM-fiber — 16
 - 1.4.2 Propagation constant and fiber modes — 23
- 1.5 Bottle resonator modes — 25
 - 1.5.1 Free spectral range — 28
- Bibliography — 29

2 Optical resonators — 30

- 2.1 Fabry–Perot cavity — 30
 - 2.1.1 Confining light between reflecting surfaces — 31
 - 2.1.2 Linewidth of a Fabry–Perot cavity — 32
 - 2.1.3 Plane-wave analysis — 33
 - 2.1.4 Spherical cavity and Gaussian modes — 38
 - 2.1.5 Transverse modes of a cavity — 40
 - 2.1.6 Stability parameter — 41
 - 2.1.7 Half-symmetric cavity — 43
- 2.2 Cavity stabilization — 44
 - 2.2.1 Ultrastable cavities — 45
 - 2.2.2 Tunable cavities and active feedback — 47
 - 2.2.3 Ultrastable lasers — 48
 - 2.2.4 Pound–Drever–Hall locking method — 49
- 2.3 Finesse measurement of a cavity — 51
- 2.4 Gravitational wave-detection and cavity interferometers — 52
 - 2.4.1 Arm cavity — 54
 - 2.4.2 Power recycling cavity — 55
 - 2.4.3 Premode cleaner cavity — 56
 - 2.4.4 Output-mode cleaner cavity — 56
 - 2.4.5 Signal extraction cavity — 57
- Bibliography — 58

3	Fiber-based resonators — 61
3.1	Why fiber resonators — 61
3.2	Different fiber-based microresonators — 62
3.3	Fabrication of the fiber Fabry–Perot cavity — 63
3.3.1	Laser machining of glass — 64
3.3.2	Microfabrication by glass ablation — 66
3.3.3	Fiber mirror production setup — 68
3.4	Interferometric techniques for surface metrology — 71
3.4.1	Michelson interferometer — 71
3.4.2	Phase-shifting interferometry — 72
3.4.3	White light interferometry — 73
3.4.4	Evaluation of mirror surfaces — 77
3.5	Mirror coating techniques — 78
3.5.1	Annealing of mirrors: enhancing reflectivity — 79
3.6	Assembling of a fiber cavity — 79
3.6.1	Ferrule-based fiber cavity — 81
3.7	Losses in fiber cavities — 82
3.8	Optical characteristics of a fiber resonator — 83
3.8.1	Multishoot technique for longer fiber cavities — 85
3.8.2	Polarization mode splitting — 87
3.9	Nanofiber and nanofiber resonator — 89
3.9.1	Adiabaticity condition for nanofiber taper — 91
3.9.2	Nanofiber resonators — 92
3.9.3	Fiber integrated Bragg mirrors — 93
3.9.4	Whispering gallery mode resonator — 94
3.9.5	Fabrication of bottle resonators — 96
3.9.6	Evanescent light coupling into a bottle resonator — 98
	Bibliography — 100

4	Cavity-QED — 102
4.1	Cavity quantum electrodynamics — 103
4.1.1	Field quantization — 103
4.1.2	Jaynes–Cumming–Hamiltonian — 104
4.2	Cavity-QED regimes — 108
4.2.1	Purcell effect — 109
4.3	Three-level system in a cavity — 111
4.3.1	Stimulated Raman adiabatic passage — 113
4.3.2	Single-photon sources — 114
4.3.3	Probabilistic vs. deterministic single-photon sources — 115
4.4	Fiber cavity-based single-photon sources — 116
4.4.1	Single-quantum emitter — 116
4.4.2	Single atom/ion coupled to a fiber cavity — 117

4.4.3	Single-photon characterization —	121
4.4.4	Quantum memories —	123
	Bibliography —	127
5	Current and future quantum technology with fiber resonators —	130
5.1	Distributed quantum information processing —	130
5.1.1	Distributed networks —	131
5.1.2	Distributed quantum networks —	132
5.1.3	Quantum repeater protocols —	133
5.2	Experimental approaches for quantum networks —	137
5.3	Fiber-network compatible quantum technology —	139
	Bibliography —	141
A	Resonator Stability —	145
A.1	ABCD Matrix —	145
A.1.1	Derivation Stability condition —	146
B	Cylindrical symmetry and Bessel function —	147
B.1	Bessel function —	147
B.1.1	Modified Bessel function —	148
B.1.2	Helmholtz equation in cylindrical coordinates —	148
B.2	Wave equation in cylindrical coordinates —	149
C	Atom-Light Interaction —	153
C.1	Quantization of Electromagnetic field —	153
C.2	Interaction Hamiltonian —	155
	Index —	159