

Index

a

- absorption effects 108, 117
- auto-correlation function (ACF) 291, 294, 300, 301, 305
- acousto-optic 328–329
- acousto-optic modulator (AOM) 23, 24
- addressing pulse 23
- Adler
 - equation 331, 334
 - frequency 332, 337, 340
 - locking range 334
- all-optical buffer 12
- amplitude equations in polaritonic basis, 374, 381 *see also* exciton-polaritons
- all-normal-dispersion (ANDi) 278, 286, 290, 294, 304
- anisotropy 317–327
 - birefringence 318
 - gain 321
 - loss 319
 - phase 317–320, 329
- anomalous dispersion 166, 171, 176
- anomalous group velocity dispersion 141, 142, 151
- aspect ratio 77
- astronomical units 27
- attractor, quasi 20

b

- bandwidth
 - gain 215–217, 220, 221
 - laser-optical 217, 218, 224
 - laser-radio frequency 217–219, 225, 226, 231
 - microcavity resonance 214, 216, 222, 224
- beat note 319, 320, 323, 325–328, 331–336, 338, 341
- bifurcation 170, 179

- cross-saturation 324, 330
- diagram 334–337
- Er:Yb:glass 318, 332
- Hopf 20, 337, 339–341
- subcritical 17
- birefringence
 - cavity 362
 - effects 108
- bistability 77–83, 88–91, 98, 99, 169, 172
 - dispersive optical 15, 17, 18
 - optical 1
 - of polaritons, 373, 376, 382 *see also* exciton-polaritons
- bistable
 - behavior 196
 - device 190
- bound state 233, 234, 238, 243, 245
- boundary conditions
 - absorbing 109, 111
 - effect on soliton dynamics 113, 121–123
 - for a ring cavity 117–118, 125
- breather 177, 178, 182
- Brillouin scattering 22
- buffer, memory
 - all-optical 86, 94

c

- canard explosion 111, 114, 122
- cavity polariton solitons, 373–389 *see also* dissipative soliton(s)
 - families of solitons 385–387
 - moving bright 373, 376–379, 387–389
 - multi-hump 378–380
 - 1D bright 373, 376–378
 - parametric polariton solitons (PPS) 380–387
 - 2D bright 387–389

- cavity soliton (CS), 12 *see also* soliton, cavity
 - interaction 25
 - Kerr 25
 - laser 12
 - plasticity 21
 - temporal 13, 21, 23
- C-band 220
- centro-symmetric structure 208
- CGL *see* complex Ginzburg–Landau (CGL)
- chalcogenide, glasses 419
- chaos 82, 97, 179, 180
 - bi- 352
 - synchronization 349
- chaotic 234, 247, 252–255, 257
 - wave fields 420
- chirp parameter 278, 280, 287, 288, 296
- chromatic dispersion 165, 166, 168
- CMOS 2, 220, 228, 419
- complex Ginzburg–Landau (CGL) 232, 238, 241
- complex Ginzburg–Landau equation 264
- compressive sensing 400, 401, 413
- continuous wave (CW)
 - component 243–245, 250
 - driven resonator 13
- conversion efficiency 202, 205
- Cubic-quintic Ginzburg–Landau equation (CQGLE) 280, 282, 285, 288, 297, 303
 - asymptotical solution 283
 - exact solution 281
 - experiment 286
 - fiber lasers 280
 - numerical solution 284
- critical coupling 195, 205, 206, 209
- cross-gain saturation 353, 355, 361
- cross-phase modulation 353
- crystalline resonator 129–132, 136, 142, 145–147, 151, 153–156
- CW *see* continuous wave (CW)

- d**
- dark soliton 177
- delay 77, 79, 80, 84, 85, 87–91, 93–97, 218, 220, 222, 225
- detuning 15
- diagram 180
- dimensionality reduction 395, 397, 414
- dispersion 16, 213, 215, 216, 220
 - anomalous 16, 27, 277, 306
 - effects 108, 117, 120, 125
 - managed system 32
 - normal 277–279
 - relation, 371–373 *see also* polariton dispersion
- dispersive Fourier-transform (DFT) technique 254, 255
- dispersive waves (DW) 31, 233, 235, 239, 246, 250
- dissipation 77, 79, 80, 83, 88, 91, 97, 99, 228
- dissipative rogue wave 265, 266, 271, 272
- dissipative soliton(s), 231–234, 236, 238–240, 242, 244, 246–250, 252, 254, 256, 263–267, 272, 369–389 *see also* soliton, dissipative
 - cavity polariton soliton (CPS) 373–389
 - cavity soliton (CS) 370
 - energy scalability 279, 283, 292, 296, 302
 - families of solitons 385–387
 - highly-chirped 278, 279, 281
 - multicolor complex 279, 309
 - Raman 279, 302
 - resonance 283, 284, 295, 296
 - weakly-chirped 280, 284
- dissipative structures, localized (LDS) 11
- domain walls 355
- drift 107–108, 125
 - in ring cavities 120–121
 - in the Swift–Hohenberg equation 109–110, 113
- drifting cavity solitons *see* soliton, cavity (CS); soliton, drifting
- driving strength 15
- dynamics, antiphase 348, 350, 353

- e**
- eigen
 - equation 318
 - frequency 319, 323, 324, 328
 - mode 328, 338, 341
 - polarization 319, 325, 330
 - state 318–327, 329, 332, 335, 342, 343
 - value 318, 319
 - vector 318–321, 323–325
- electrostriction 27
- equation-free 395, 396, 402, 409, 414
- erbium (Er)-doped fiber amplifier 357, 359, 360
- Er-doped 235, 250, 255
- excitability 80, 82, 88, 90–93, 97, 99, 113
 - of cavity solitons *see* soliton, cavity (CS); soliton, excitable
 - of dissipative solitons *see* soliton, dissipative; soliton, excitable
- quasi-threshold 114, 115
- threshold 113
- types of 113–114
- exciton-polaritons 369–389
 - amplitude equations 371, 374, 381
 - bistability of polaritons 373, 376, 382

- cavity polariton solitons (CPS) 373–389
- dispersion of polaritons 371–373
- Hopfield coefficients 372–373
- modulational instability (MI) 378–379, 387
- nonlinearity of polaritons 372, 375
- parametric interaction of polaritons 379–381, 383, 385–387
- polaritonic basis 372–373
- saturation of Rabi splitting 372
- exploding soliton 263, 264, 266–269, 272
- external injection 233, 245
- extremum-seeking control 402, 403, 407, 410

f

- feedback 79, 80, 89–91, 93–99
 - delayed 323, 330, 333–334
 - frequency-shifted 318, 320, 327–341
 - loop 279, 302, 304, 306, 307
 - optical 79, 80, 91, 93–99
 - optoelectronic 89, 90, 98
- femtosecond pulse 277, 278, 290
- Fermi–Pasta–Ulam, recurrence 16
- 2f–3f method 154, 155
- fiber
 - dispersion
 - – compensating 359
 - – shifted 359
 - erbium doped fiber amplifier (EDFA) 220–224
 - laser cavity 213–215, 220, 222
 - lasers 5, 347, 357, 420
 - – vector 350, 353, 362
 - resonator 83
 - twist 199
 - ytterbium doped fiber amplifier (EYDFA) 221, 222, 224
- figure of eight laser (F8L) 232, 240, 249
- F8L *see* figure of eight laser (F8L)
- four wave mixing 213, 214
 - dissipative four wave mixing (DFWM) 213, 214, 228
 - filter drive four wave mixing 214, 215, 224, 228
- fragmentation 238
- free spectral range (FSR) 165, 166
 - fiber cavity loop 213, 214, 216–222, 224, 226–228
 - filter 213
 - microcavity 217, 218, 221, 223, 224, 228
- frequency comb 4, 318, 325, 326
 - Jones 318
 - matrix 318, 321
 - vector 325

- frequency-resolved optical gating (FROG) 293, 300, 301, 305
- front 77, 80, 88, 89
 - pinning 88–92, 99

g

- gain 173, 176, 215–217, 220, 221
 - bandwidth 215–217, 220, 221
 - bandwidth-limited 351
 - dynamics 239, 241–244
 - saturable gain 215
 - saturation 353
- Gaussian distribution 203
- Ginzburg–Landau equation 107, 349
- gradients 21
- group velocity dispersion (GVD) 31

h

- harmonic generation
 - second (SHG) 190, 200
 - third (THG) 190, 200
- harmonic mode-locking (HML) 233, 234, 242, 244–247
- heteroclinic, connection 90
- high-chirp limit 283, 285
- higher-order dispersion, 374–375 *see also* polariton dispersion
- HML *see* harmonic mode-locking (HML)
- homoclinic
 - connection 88
 - orbit 97
 - snaking 80, 88, 90, 99
 - trajectory 352
- homogeneous response 19
- Hopf
 - bifurcation 20, 349
 - threshold 29, 30
- hybrid (HE,EH) modes 191
- hyperbolic-secant pulse 21
- hysteresis 196, 197, 233–238, 256

i

- inflection point, 370–371, 374 *see also* polariton dispersion
- inhomogeneity *see also* polariton dispersion
 - applying a perturbation to 114
 - in periodically pumped ring cavities 119–123
 - in the Swift–Hohenberg equation 109–111
- injected CW *see* external injection
- instability 235, 243
 - Benjamin–Feir 351
 - modulation (MI) 15, 17, 18, 213

instability (*contd.*)

- modulational 351
- radio frequency 214, 221, 224, 225, 227, 228
- Risken–Nummedal–Graham–Haken 358
- supermode instability 214, 219, 221, 224
- interaction (soliton) 232, 233, 235, 238, 239, 244–247, 250, 256
- interaction strength 25

k

- Kelly sidebands 32
- Kerr
 - comb generation 32
 - combs 116, 129, 130, 133, 134, 141, 144, 148, 163–167, 173, 175, 182
 - effect 117, 232, 237, 246
 - frequency combs 116, 125
 - nonlinearity *see* Kerr, effect

l

- laser
 - cavity 278, 279, 295, 297, 302, 304
 - dissipative four wave mixing 213, 214, 228
 - fiber 277–281, 286, 289, 291–293, 295–298, 302, 310
 - filter drive four wave mixing 214, 215, 224, 228
 - forced-, driven-, injected 78, 86, 92–98
 - mode-locked 213
 - modulation instability 213
 - multimode 79, 91, 97, 98
 - ring 97, 98, 280, 292, 297
 - semiconductor 77–84, 86, 88, 93, 94, 98
 - solid-state 317, 320, 323, 327, 328, 330, 339
 - soliton 78, 79
 - supermode instability 214, 219, 221, 224
 - vertical cavity surface emitting 77, 78, 80, 81, 86, 89, 91, 95, 98
- lidar–radar 333
- light
 - bullets 3
 - emission, chaotic 350
- limit cycle 31
- localized structures, 4, 77–91, 94, 95, 97–99, 369–389 *see also* dissipative soliton(s)
 - chaotic 82
 - lasing 78, 98
 - spatial 79
 - temporal 78, 79, 83, 87, 98
- locking
 - frequency 318, 320, 323, 341

- frequency-without phase 334, 336
- injection 317, 318
- Laser Optical Feedback Imaging (LOFI) 328
- mode 317, 318
- phase 318, 325, 327, 332–334, 337–341
- range 326, 327, 332–334
- self 318–327, 341
- lower-polariton branch, 373, 375, 381 *see also* polariton dispersion
- Lugiato–Lefever equation (LLE), 3, 15, 21, 31, 34, 118 *see* spatio-temporal, model
 - derivation for a ring cavity 116–118
 - homogeneous solutions 118
 - with inhomogeneities and drift 120–121
 - patterns *see* pattern(s), in the Lugiato–Lefever equation
 - solitons *see* cavity soliton (CS)

m

- machine learning 395–398, 405, 406, 409, 413, 414
- “magic angle,” 370–371, 374 *see also* polariton dispersion
- master diagram 283, 296
- memory, buffer
 - all-optical 86, 94
- microcavity, 214–223, 227, 228, 369, 371, 420 *see also* microresonator
 - free spectral range (FSR) 217, 218, 221, 223, 224, 228
 - modes 216–220, 224, 225
 - quality factor (high-Q) 214, 219, 220, 228
 - resonance bandwidth 214, 216, 222, 224
- microcoil resonator 189, 190
 - broken 197
 - uniform 193
- microfiber, optical 189
- microresonator, 4, 369, 371 *see also* microcavity
 - microresonator with quantum well (QW) 369, 371
 - planar microresonator 369, 371
 - semiconductor microresonator 369, 371
- mirror
 - imperfections 108
 - misalignment effects 108
- modal expansion model 166, 167, 174
- mode(s)
 - cavity modes 213, 214, 216–221, 223–225, 227
 - dispersion curve 191
 - locking 278, 280, 287, 290–293, 296, 298, 302, 310

- microcavity modes 216–220, 224, 225
- mode-locking 213, 214, 217, 218, 227, 228
- phase of a mode 213, 219–222, 225, 227, 228
- supermodes 213, 214, 219, 221, 224
- mode-locked lasers 395, 396, 403, 409 411, 414
- mode-locking 350
 - passive- 353
 - polarization- 347
- mode-locking (passive) 78, 82–85, 87, 98, 213, 214, 217, 218, 227, 228
 - fundamental 82–85
 - harmonic 83–85, 87
- modulational instability of polaritons 378–379, 387
- modulation(al) instability, 6 *see also* primary comb
- multiple pulsing 233–236, 248, 252, 257
- multipulse *see* multiple pulsing
- multiscale approach 241
- multistability 85, 86, 233–235, 237

n

- nonlinear amplifying loop mirror (NALM) 292
- nanofiber, optical 189
- nanophotonics 189
- Nd:YAG 320, 324, 328, 342, 343
- neural network 421
- Newton cradle 123
- NLP *see* noise-like pulse (NLP)
- NLSE *see* nonlinear Schrödinger equation (NLSE)
- noise
 - amplified spontaneous emission 357
 - laser amplitude noise, 214, 221, 224, 225, 227, 228 *see also* radio frequency instability
 - laser phase noise 214, 226, 228
- noise-like pulse (NLP) 234, 244, 247, 252, 253, 255, 257, 265, 266
- nonlinear optical loop mirror (NOLM) 280, 292
- nonlinear
 - polarization evolution 347
 - saturable gain 351
 - Schrödinger equation 350
- nonlinear polarization evolution (NPE) 232, 235, 236, 238, 250
 - overdriving 289, 293
 - overdriving-free 279, 290
 - scalar form 299
 - vectorial model 288

- nonlinear Schrödinger equation (NLSE) 14, 117, 118, 168, 279, 285, 298, 302, 303
 - externally-driven 14
- nonlinear transfer function 198
- nonlinearity 278, 280, 287–289, 293, 298, 306, 311
 - effective 192
 - multipole 208
 - surface dipole 208
 - thermal 199
- normal dispersion 166, 175, 177
- NPE *see* nonlinear polarization evolution (NPE)
- numerical methods
 - Fourier-transform 298
 - symmetrized split-step 298

o

- optical microcoil resonator (OMR) 189
- optical micro-nanofiber (OMN) 189
 - loop resonator 205
 - uniformity 209
- optical micro-resonators 189, 193–197
- optical rogue wave 265
- optomechanical, resonator 420
- overlap integrals 202

p

- parametric interaction of polaritons 379–381, 383, 385–387
 - amplitude equations 381
 - signal, idler and pump polaritons 381
- passive Q-switching 317, 318, 329, 331, 333–334, 342, 344
 - bounded 318, 334–341, 344
 - drifting 335, 337, 338, 344
 - entrainment 334, 344
 - noise 340, 344
 - noise spectrum 339, 340
 - phase 333
 - phase-amplitude coupling (Henry factor) 330, 340
 - phasor plot 337–339, 344
 - trapping 334, 345
- pattern(s) 107–108
 - in the Lugiato–Lefever equation 118–119
 - periodic 17
 - in the Swift–Hohenberg equation 108–109
 - turing 16
- pattern (soliton) 233, 234, 238, 240, 241, 244–247, 256, 257
- Pearson correlation coefficient 360

- Pereira–Stenflo solitary wave 355
- phase
 - kink, soliton 80, 91
 - locked loop 228
 - matching 200, 201, 203
 - of mode 213, 219–222, 225, 227, 228
 - noise 214, 226, 228
 - optical 78, 91–99
 - space 87, 90, 92, 93, 95
 - space topology 80, 91, 99
 - symmetry 78, 80, 82, 98
 - transition 248, 256
- phase-locking 173
- phase-transition
 - curve 349
 - diagram 350, 362
- piezoelectric fiber stretcher 22
- platform, technological 419
- polariton dispersion 371–373
 - higher-order dispersion 374–375
 - inflection point 370–371, 374
 - lower-polariton branch 373, 375, 381
 - “magic angle,” 370–371, 374
 - upper-polariton branch 373
- polaritons, 369–389 *see also*
 - exciton-polaritons
- polarization
 - chaos 359
 - Cr:YAG 329, 330
 - dependent loss 358
 - domain 355
 - – wall 348, 356, 357, 361, 362
 - – wall soliton 356
 - dual 317–330, 332, 342–344
 - dynamics 7
 - helicoidal 324, 343
 - hole burning 347
 - insensitive optical isolator 358
 - Lang–Kobayashi 330
 - mode dispersion 356, 362
 - rate equations 317, 332, 333, 335, 342
 - relaxation oscillations 317, 320, 328–331, 337, 341
 - Runge–Kutta 332
 - saturable absorber 324, 329, 330, 343
 - self-modulation 318, 321, 323, 327, 342, 343
 - self-pulsing 318–320
 - state of 357
 - stiffness 331
 - time-scaled 331
- primary comb 171, 174, 179
- principal component analysis 397
- probability density function 270, 271
- pulsations
 - antiphase 353
 - self-starting 358
- pulses
 - antiphase- 360
 - noise-like 348
- q**
 - quality factor 165
- r**
 - Rabi splitting, 358, 372–373 *see also*
 - exciton-polaritons
 - radio frequency instability 214, 221, 224, 225, 227, 228
 - Raman gain 295, 296, 298, 304, 307
 - Raman pulse 290, 293–295, 297, 298, 302, 303, 306
 - resonances 166
 - resonator 165
 - knot 189
 - loop 189
 - microcoil 189
 - rogue wave 6, 181, 234, 247, 253–257, 420
- s**
 - self amplitude modulation (SAM) 280, 281, 283, 289, 291
 - Semiconductor saturable absorber mirror (SESAM) 324, 325, 327, 343
 - saturable absorber 78, 80, 82–84, 86, 98, 279, 280, 291
 - fast 347, 348, 350
 - shock 352, 354
 - saturable gain 215
 - scalar equation 237, 238
 - self-phase modulation 202, 206
 - self-referencing 130, 154, 155, 163
 - shock 352, 354
 - significant pulse peak power 271
 - silicon
 - nitride 419
 - – resonator 31
 - photonics 419
 - slow light 195
 - slowly varying envelope 166
 - soliton 11, 176, 180
 - advected 111, 115
 - cavity (CS) 2, 12, 78, 80, 107, 116
 - crystal 6, 233, 234, 238–248, 256
 - dissipative 2, 11, 20, 77, 80, 83, 97, 99, 107–108, 125, 347
 - drifting 121, 123–124
 - effect of boundary conditions 123

- evolution after a perturbation 123–124
 - excitable 114–116, 123
 - gas 247–249
 - Kerr 12
 - liquid 247, 248, 250
 - molecule 177, 233, 238, 239, 243, 247, 256, 257
 - optical 2
 - oscillatory 114
 - periodic emission 111
 - phase 80, 91
 - pinned 110, 111, 120, 121, 123
 - polycrystal 247, 249
 - rain 234, 244, 247, 250–252
 - stationary 119
 - in the Swift–Hohenberg equation 109
 - temporal 354
 - topological 99
 - train of 111–112, 114, 122–123, 125
 - vector 347
 - vector dark 356
 - soliton–solitary pulses 213, 222, 225, 228
 - sparsity 400–402, 406, 412, 413
 - spatial
 - inhomogeneity *see* inhomogeneity
 - structure *see* pattern(s), dissipative soliton(s), cavity soliton (CS)
 - spatio-temporal
 - chaos 354
 - chaotic attractor 353
 - dynamics 420
 - intermittency 352, 353
 - model 167
 - spectra
 - optical 286, 293, 294, 306
 - radio frequency 293, 305
 - self phase modulation (SPM) 280, 281
 - stimulated Raman scattering (SRS) 279, 296
 - model 298
 - multiple-vibrational-mode 298
 - threshold 292, 296
 - stability analysis 168
 - steady-state equilibrium 168, 176
 - step-index fiber 191
 - Stokes parameter 357
 - strong light-matter coupling, 369–389 *see also* exciton-polaritons
 - subcritical 171, 180
 - supercritical 171, 179
 - supermode suppression 244, 246, 248
 - surface roughness 203
 - Swift–Hohenberg equation 108
 - dispersion relation 109
 - with inhomogeneities and drift 109
 - Lyapunov functional 108
 - patterns *see* pattern, in the Swift–Hohenberg equation
 - solitons *see* soliton, dissipative; soliton, in the Swift–Hohenberg equation
 - symmetry, translation 13, 21
- t**
- tapering, optical fiber 189
 - temporal cavity solitons 13, 21, 23
 - breathing 29
 - thulium, fiber laser source 209
 - train
 - of pulses 119, 120, 125
 - of solitons *see* soliton, cavity (CS); soliton, dissipative; soliton, train of
 - transverse electric (TE) modes 191
 - transverse magnetic (TM) modes 191
 - turbulence
 - amplitude 352
 - phase 352
 - turing pattern *see* primary comb
- u**
- upper-polariton branch 373 *see* polariton dispersion
- v**
- vertical-cavity surface-emitting laser (VCSEL)
- w**
- wavelength converters 420
 - acoustic response 28
 - wavelength-division multiplexing (WDM) 281, 286, 292, 293, 298, 300, 306–309
 - whispering gallery mode
- z**
- zero-dispersion wavelength (ZDW) 31

