

Index

symbols

- χ^2 264, 510
- χ^2 test 228, 269

a

- A_2 16, 110, 118, 337–338, 353, 459, 471, 491, 504–506
- A_3 16, 109, 118, 130, 337–338, 353–354, 491, 504–505, 507

$A_3 \rightarrow A_2$ 395

absorbing cell 285

absorbing manifold 494

accumulation 9

Achilles' Heel 139

action-angle variables 497

action integral 209

Adams integration 291

additive noise 117

address 202, 204

adiabatic elimination 298

admissible sequence 54

Ado's algorithm 124

affine transformation 472, 501

A_k 129, 246, 361, 491, 503, 505–506

Alexander 148

Alexander's theorem 148, 150, 159

algebra

- higher 126

- lower 126

algebraic description, of branched manifold 180

alphabet 216, 230, 260, 263

alternative hypothesis 258

ambient isotopy 148

ambient temperature 328

amplitude 252, 346, 350, 392

amplitude variation 289

Ampère 146

analytic 240

- continuation 392

- models 233

- representations 283

angular momentum integral 443

annulus 159, 192

- map 100, 142, 413

approximation, by rational functions 236

Arnold tongues 98

- and subtemplates 222

- overlap 222

array 230–231, 310, 317

- joining 264

art form 237, 254

asymptotic future 182

asymptotic regime 19

atomic polarization 298

atomic resonance 344

aufbau principle 429

autonomous 106, 117, 125

b

backward sequence 60, 79

basins of attraction, coexisting 375

basis functions 233, 283

basis set

- of loops 209

- of orbits 374, 389, 457

- of polynomials 291

basis, integrity 393

beam splitter 311

Belousov–Zhabotinskii data 375

Belousov–Zhabotinskii reaction 241, 250, 257, 259, 272

Bezout's theorem 504

bifurcation

- of fixed points 127, 132

- peeling 404

- bifurcation diagram 7, 22
 - Lorenz equations 339
 - of cusp map 470
 - bifurcation organization 170
 - bifurcation set 127
 - Lorenz equations 129
 - Rössler equations 128
 - binary system 204
 - binormal 445
 - Birman–Williams identification 458, 490, 496
 - Birman–Williams projection 181–182, 185, 192, 210–211, 459, 465
 - Birman–Williams theorem 178, 181, 183, 210, 224, 274, 461
 - blow-up, of branched manifolds 210
 - blowing up 411
 - boundary conditions 111
 - topological 477
 - boundary layer 138, 179
 - boundary, trapping 494
 - bounding tori, canonical forms 429
 - boxes within boxes 475
 - braid representation, of branched manifold 186
 - braid type 173, 368, 372
 - and relative rotation rates 172
 - partial ordering 379
 - periodic orbits of surface homeomorphisms 380
 - braid word 151
 - braids 148, 250, 296
 - boundary conditions 150
 - geometric 379
 - group 150, 195
 - moves 150
 - relations 150, 195
 - topological entropy 382
 - branch line 177, 211, 230, 321, 462, 496
 - and squeezing 180
 - Branch line reversal 195
 - Branch line splitting 195
 - Branch line twists 195
 - branch rectangles 210
 - branched manifolds 15, 175–176, 227, 231, 457, 496, 499
 - algebraic description 180
 - and knot polynomials 180
 - and topological entropy 213
 - as germs 362
 - braid representation 186
 - covers of 402–404
 - for Lorenz attractor 188
 - for van der Pol attractor 192
 - global moves 197
 - images of 396, 403
 - local moves 195
 - properties of 178
 - standard form 200
 - standard representation 186
 - unfolding of 377
 - branches 177, 263
 - feeding 433
 - starving 433
 - breaking, of magnetic field lines 176
 - Brewster angle 5
 - Brewster angle windows 5, 285
 - bubbles 417
 - Burke and Shaw
 - attractor 507
 - dynamical system 399, 403
 - equations 395
 - burst 329
- c**
- canonical form 134, 496
 - capacity 219
 - catastrophe machine 477
 - catastrophe theory 18, 357, 362, 493
 - catastrophes 357
 - Cauchy's theorem 240
 - caustics 504
 - cavity losses 299
 - cavity resonance 344
 - CCD 229, 244
 - change of variables 120, 123
 - channel capacity 220
 - chaos
 - routes to 24, 502
 - test for 258
 - chaotic attractor 10
 - chaotic orbits 203, 205
 - characteristic equation 219
 - chemical reactions 4
 - chi-squared 510
 - test 563
 - circle 478
 - circle map 222, 413
 - double fold 471
 - for van der Pol oscillator 192
 - class B laser 295, 297
 - model 298
 - classification
 - macroscopic level 389
 - microscopic level 389
 - of dynamical systems 178
 - of strange attractors 178

- Clebsch–Gordan coefficients 116, 338
close returns 232, 235, 256–257, 273,
 309, 347
 – histogram 258
 – method of 143, 229
 – plot 256, 258
closed 116
closed loop 175
coexistence 375
coexisting basins 9, 375
communication
 – channels 219
 – systems 220
 – theory 219
commuting operators 502
complex extensions 504
computational load 557
concatenation
 – of inflows 195
 – of outflows 195
concentration gradient 328
conjugacy 32
 – smooth 32
 – topological 32
conjugation
 – of braid word 151
 – of orbits 347
 – of symbols 202
connected sum 480
connection
 – heteroclinic 354
 – homoclinic 354
conservative 86
conservative dynamical system 177
constitutive relation 110
continuation
 – analytic 392
 – group 392
continuously stirred tank reactor 272
control parameters 11, 105
convention, sign 147
core
 – of torus 445
 – of trinion 452
correlation dimension 550
coset 126
coupled diode resonators 469
coupled oscillator embeddings 290
cover 16, 391, 393, 403, 507
cover dynamical systems 354
cover–image relation 508
covering equations 406
Coxeter–Dynkin diagrams 504
crisis 473, 475
critical points 126–127, 229, 260, 263,
 265, 357
 – degenerate 360, 362
critical slowing down 334
cross product 136
crossing information 146
crossing matrix 163, 207
CSTR 272
current 109
current discharge 285
curse, too much data 545
cusp 16, 118, 130, 246, 338, 464, 466, 468,
 501, 507
 – multiple 475
 – return map 472
 – weakly coupled systems 467
cusp catastrophe 354
cusp map 132, 474
cuspid 246, 361, 491, 501, 503
 – universal perturbations of 361
cycle time 235, 238
cycles 235
cyclic permutation 163
 – matrix 207
cylinder 45, 479
- d**
 D_4 501, 504, 506
data requirements 235
decay rate 298
deep minimum problem 295
deformation 107, 491, 500
degeneracy 267
 – of fixed points 127
degenerate critical point 360, 362
delay 249
delay embedding 255
dense 183, 205
density operator 344
derivative
 – and differences 250
 – generalized 239
 – noise-free 241
devil's staircase 99
diffeomorphism 20, 120, 497, 542
 – global 121
 – local 121, 393, 497
differential embedding 244, 246, 274
differential equations, stochastic 116–117
dimension
 – Lyapunov 229
 – partial 460

- Dirac 113
- directed network 452
- discrete dynamical systems 106
- discrete invariant subgroups 508
- disk 479–480
- dissipation rate 229
- dissipative dynamical systems 229
- divergence 136
- divergence theorem 136
- D_1 247, 361, 491, 503, 505–506
- donut, hollow 222
- Doppler line width 345
- double covers 402, 406
- dreibein 452
- drift 238, 335
- drift time 322
- driving period 412
- Duffing attractor, template for 189
- Duffing dynamical system 403
- Duffing equations 107, 412, 507
 - symmetry of 118
- Duffing oscillator 189, 392, 409, 439
 - symmetry of 407
- dynamical invariants 233
- dynamical systems 105
 - chaotically driven 125
 - classification of 178
 - conservative 177
 - continuous 105
 - equivariant 393
 - shift 59
 - symbolic 59
- dynamics, model 232

- e**
- E_6 361
- E_7 361
- E_8 361
- EBK quantization 209
- echo 126
- Einstein–Brillouin–Keller quantization 209
- E_k 247, 505–506
- electric field 344
- electrical grid 239
- elliptic 481
- embed data 227
- embedding 229, 235, 243, 257, 262, 438, 494, 541
 - coupled oscillator 251
 - delay 250
 - differential 244
 - integral-differential 247
 - problem 243

- f**
- Fabry–Pérot cavity 308
- false near neighbors 257, 290, 547
- Farey sum 98
- fast Fourier transform 234, 239
- Feigenbaum scenario 9
- FFT 234, 238, 241
- fiber-optic laser 298, 311, 362
- Fibonacci equation 155, 167–168
- figure 8 knot 176, 429, 542
- filter 247
 - high frequency 238
 - low frequency 238

- fingerprints 139
 finite difference equations 219
 finite orbits 204
 finite-order orbits 372
 first differences 237
 first return map 131, 133, 229, 296, 330
 first return plots 273
 fixed point distributions 504–505
 fixed points 25, 125–126
 - bifurcations 127
 - bifurcations of 132
 - Lorenz equations 338
 - stability 130
 - stability of 133
 flat 481
 flip saddle 330
 floppiness 462
 flow 7
 flow direction 180
 flow equivalent 194
 flow tubes 233
 flows 105
 - flows, in higher dimensions 457
 fluid experiments 352
 fluid mixing 383
 fold 16, 118, 246, 338, 459, 464, 466, 471, 474, 501, 507
 fold lines 468
 fold mechanism 354
 folding, extended 190
 folds, unfolding of 362
 forbidden transitions 231
 forcing 287
 - topology of 365, 368
 forcing diagram 158, 365, 369, 502
 forward sequence 60, 79
 Fourier, interpolation 241
 Fourier, modes 117, 337
 Fourier, series 445
 fractal dimensions 1, 210, 236
 fractal structure 210
 fractions, base n 205
 framing index 446
 frequency domain 234, 238
 frequency locking 96
 full shift 199
 full-shift dynamics 218
 fully reducible 124, 498, 510
 fundamental idea 138
 fundamental loops 208
- g**
- Galerkin projection 116, 392
 gate mechanism 328
 Gauss 145–146
 Gaussian random numbers 258
 gbasis 127
 general linear model 228, 264, 266, 269, 510
 generalized derivatives 239
 generalized integrals 239
 generically 254
 genus 422
 genus-g attractor 450
 germ 16, 357, 359, 362, 498
 - and branched manifolds 362
 - simple 361
 - unimodal 361
 - variables 500
 ghost rods 385
 ghosts 131, 339
 Gibbs phenomenon 241
 Ginzburg–Landau potential 357
 global 507
 global boundary conditions 192
 global diffeomorphism 121
 global equivalence 121, 391
 global torsion 15, 164, 170, 296–297, 316, 320, 412, 440–441, 448
 globular cluster 234
 Goldilock’s problem 543
 goodness-of-fit 264, 510
 Gram–Schmidt procedure 266
 grammar 230, 263
 graph 220
 gravitational interaction 107
 group
 - discrete 393
 - symmetry 393
 group action 118
 group continuation 392
 Gröbner 127, 131
 Gröbner basis 126
 gsolve 127
 gâteau roulé 15, 271, 298, 320, 322, 331, 334–335, 354, 409
- h**
- Haken 343
 Haken–Lorenz model 344
 handlebody 422, 450, 456
 harmonic curves 542
 harmonic knot 445
 heat conduction 111
 Heaviside function 256, 550
 Hessian 358
 heteroclinic connection 354

- high frequency filter 238
- Hilbert transform 240–243, 251
- Hodgkin 328
- Hodgkin–Huxley equations 328
- hole in the middle 150, 201, 278, 299
- homeomorphisms 20
- homoclinic
 - connection 354
 - loop 90
 - points 88
 - tangencies 91, 96
 - tangles 96
- homogeneous spaces, singularities 480
- homotopy 144
 - group 502
 - index 164
- Hopf–Arnold tongue 269
- Hopf bifurcation 192, 222, 340, 473, 475
- horseshoe 35
 - map 153, 412
 - mechanism 163
 - reverse 311
 - subtemplates of 221
- horseshoe branched manifold
 - unfolding 365
 - with global torsion 317
- horseshoe dynamics 231
- horseshoe orbit
 - 3_1 217, 366
 - 4_2 366
 - 5_3 366
- Huxley 328
- Huyghens 234, 510
- hydrogen
 - atom 337
 - molecule 337
- hyperbolic 85, 216, 481
 - strange attractor 185, 228
- hyperbolicity 218
- hypothesis
 - alternative 258
 - null 258
- Hénon map 131, 134, 141, 171
- i*
- image 391, 393, 403
 - dynamics 408
 - equations 394
 - flows 394
 - of dynamical systems 354
- implicit function theorem 358
- inadmissible sequences 217
- incidence matrix 180, 187–188, 201, 213, 230–231
- incompressibility condition 111
- index 423
- inertial manifold 185, 229, 329, 461, 490, 494
- inflation 421
 - of branched manifolds 210
- inflow 180
- information 391
- initial condition 228
- inner product 266
- integral
 - generalized 239
 - surface 136
 - volume 136
- integral–differential embedding 247, 286
- integrity basis 393–394, 408
- intensity 350, 392
- intermittency 502
- interpolate 235
- interpolation 236
 - Fourier 241
- interspike time interval 329
- interval 478
- invariant tori 471, 473
- invariants
 - coordinate 53
 - dynamical 233
 - equations 395
 - functions 502
 - manifold 377, 389
 - measure 266, 291
 - metric 233
 - subspace 393
 - topological 233
- inversion operation 408
- inversion symmetry 248, 407
- irrational numbers 183, 203, 205
- irrationals 205
- irreducible 124, 498, 511
 - forbidden words 60
- isotopy 177, 184, 438
 - ambient 148
- iterated torus knots 371
- itinerary 43
- j*
- Jacobian 465
- jellyroll 15, 271, 298, 320
 - mechanism 335
- joining array 180, 187–188, 201
- joining singularity 427
- k*
- Kaplan–Yorke conjecture 312

- Kaplan–Yorke estimate 461
 Katz 328
 Kelvin 145
 Kerr cell 5
 Kirchhoff 289
 Kirchoff's laws 109
 Klein bottle 479–480
 Klein–Gordon equation 113
 kneading sequence 51, 94
 kneading theory 48, 202
 knot holder 15, 175–176
 knot index, generalized 452
 knot theory, higher dimensions 482
 knot type 440, 445, 447, 453
- I**
- Labrador sea, mixing 385
 Lagrangian singularities 504
 laminar limit 502
 Landau–Ginzburg potential 357
 laser equations 106
 laser with saturable absorber 285, 362
 LDU decomposition 267
 least-squares 266
 Legendre polynomials 266
 Lego 180
 Lie algebras 124
 Lie group theory 18, 493
 lift 403
 Lille 297
 linearization 130
 link
 - oriented 148
 - standard representation 148
 linking numbers 15, 139, 145, 157, 177, 205, 227, 229, 244, 256, 262–263, 333, 401
 - and global torsion 170
 - for Lorenz attractor 154
 - for period-doubling cascade 154
 - for Rössler attractor 153
 linking, twist and writhe 157
 Lipschitz condition 106
 Lipschitz property 107
 local 507
 local diffeomorphism 121, 393, 418, 497
 local equivalence 121, 391
 local Lyapunov dimension 185
 local singularities 507
 local torsion 155, 230, 260, 263
 locally faithful 507
 locking, of modes 222
 logarithmic amplifier 309
 logistic map 471–472
 - coupled 467
 longitude 423
 longitudinal modes 311
 loop closing 232–233
 Lorenz 112, 338, 494, 505
 Lorenz attractor 248, 341, 391, 507
 - branched manifold for 188
 Lorenz branched manifold, unfolding of 364
 Lorenz dynamical system 403
 Lorenz equations 111, 113, 143, 248, 337, 392, 395, 504
 - bifurcation diagram 339
 - bifurcation set 129
 - change of variables 123
 - fixed points 128
 Lorenz mechanism 188, 353
 Lorenz system 399
 loss rates 6
 low frequency filter 238
 LSA 285
 Lyapunov dimension 143, 178, 185, 210, 229, 234, 291, 312, 461
 Lyapunov exponents 1, 36, 135, 137, 178, 228, 234, 261, 269, 281, 291, 322, 459, 496
 - largest 548, 554
 - local 135, 460

m

Mac II 236
 magnetic field lines 175, 177
 Malkus–Robbins equations 549
 map

 - annulus 100, 413
 - bi-unimodal 95
 - circle 413
 - first return 259
 Maple 126
 mapping

 - differential 544
 - Hilbert transform 544
 - integral-differential 544
 - SVD 545
 - time delay 543
 Markov chains, topological 61
 Markov partition 64
 Markov transition matrix 201, 216, 219, 231
 Maslov index 209
 maximum likelihood 266
 mechanism 439

 - stretch and fold 420
 - tear and squeeze 420
 membrane polarization 328
 membrane potential 329
 memory 238, 276

- memory loss 247
 memory time 238
 meridian 423
 metamorphoses 218
 metric 261
 - invariants 233, 269
 - methods 261, 376
 - properties 234
 missing orbits 264, 375
 mixing 37
 modality 505
 mode amplitudes 116
 mode locking 471, 502
 model dynamics 228, 232, 265
 model verification, of BZ models 283
 models
 - of BZ reaction 283
 - of stringed instrument 290
 - validation of 233, 268
 modulation amplitude 6
 modulation frequency 309
 modulus 499
 Morse
 - canonical form 361
 - lemma 358
 - normal form 358
 - quadratic form 358
 mother-daughter pair 166
 multichannel analyzer 295, 313
 multiple cusps 475
 multiplicative noise 117
 multitable 7
 multitorsion index 451, 453, 456
 musical instrument 234
 mutual information 290
 Möbius strip 166, 286, 479
- n**
- natural period 412
 Navier–Stokes equations 111, 116, 118, 337, 494
 needle in a haystack 561
 negative-frequency 241, 243
 nerve cell 362
 neurons
 - platonic 328
 - sensory 328
 - with subthreshold oscillations 328
 Newton–Raphson procedure 300
 Newtonian motion 107
 Nielsen–Thurston classification theorem 379
 Noether 394
- noise 233, 269, 560
 - additive 117
 - multiplicative 117
 noise-free derivative 241
 nonautonomous 106, 117
 nongeneric 218, 255
 nonideal springs 107
 nonlocal 508
 nonorientable 479
 nonrepeating sequence 203
 nonstationarity 276
 nonuniqueness, of branched manifold representations 194
 normal 445
 - distribution 559
 - form 134
 - modes 117, 254, 337
 null hypothesis 258
 numbers
 - irrational 183
 - rational 183
 Nyquist frequency 239, 241
- o**
- one-dimensional entropy 371
 one-sided 166
 open systems 272
 operators, commuting 502
 optical parametric oscillator, chaos 386
 orbit creation, order of 172
 orbit forcing 74
 orbit labels 232
 orbit organization 144
 orbit organizer 175
 orbits
 - allowed 219
 - basis set 374
 - dressed 145
 - eventually periodic 204
 - finite 204
 - labeling of 263
 - missing 264, 375
 - positive entropy 372
 - pruned 218–219
 - under a group 126
 - with positive entropy 372
 - with zero entropy 371
 order of a shift 61
 ordinary differential equations 105
 orientation preservation 483
 orientation preserving 202, 286
 orientation-reversing 202, 286
 oriented link 148

- outflow 180
 overlap integrals 266
- p**
 padding 243
 pants 428
 - pairs 451
 parabolic 481
 parity 202, 330, 440, 447, 451, 453
 - of branches 202
 partial dimensions 460–461, 496
 partition 43
 - generating 45
 partition function 253
 partners 126
 paths 502
 peeling bifurcation 404
 perestroika 9, 11, 16, 335, 362, 412, 432
 - of Duffing oscillator 409
 - of orbits 405
 - of scroll template 320
 - of van der Pol equations 415
 perihelion 176
 period-doubling bifurcation 8
 period-doubling cascade 8–9, 155, 471, 474
 periodic boundary conditions 159
 periodic driving 118
 periodic orbits 131, 228
 - covers of 403
 - image 398
 - locating 131, 227
 - order of creation 158
 periodic windows 471
 permutation 296
 permutation matrices 163
 perturbation
 - general 359
 - universal 500
 phase space 106
 - structure of 118
 - topology of 125
 phase synchronization 334
 Poincaré 11, 14, 209
 Poincaré–Bendixon theorem 257
 Poincaré–Hopf index theorem 423
 Poincaré map 7
 Poincaré section 7, 106, 126, 131, 159, 210, 246, 257, 259, 264, 292, 300, 458
 Poincaré surface 429, 432
 polarization minimum 330
 polarization states 311
 population inversion 5, 298
- port
 - input 428
 - output 428
 positive-entropy orbits 372, 388
 positive-frequency 241, 243
 potential 108
 power spectrum 235
 preimages 216
 prejudice 177
 pressure 285
 pressure field 111
 principal part 241
 program 493
 program, topological analysis 227
 projection 461
 - Birman–Williams 182, 496
 - equivalence under 195
 - Fourier 545
 - phase space 546
 - SVD 252, 546
 projective plane 479
 pruning front conjecture 94
 pseudo-Anosov representative 379
 ρ th return map 229
 pump mechanism 328
- q**
 QOD orbits 372
 qualitative model 232
 quantitative model 232
 quantization, EKB rules 209
 quantum numbers 209
 quasi-one-dimensional orbits 173, 372
 quasiperiodic 96
- r**
 radiation field 298
 rank 465, 502
 - of a dynamical system 129
 - of catastrophes 129
 - of singularities 129
 - of singularity 501
 rational fraction 203
 rational fractional function 283
 rational fractional models 268
 rational function 236
 rational interpolations 237
 rational numbers 183
 real forms 506
 recurrence plots 256–257
 recurrent nonperiodic behavior 1, 137
 reducibility 497
 reducible 83, 124–125, 498, 510

- reduction of dimension 494
- reference filament 136
- reference orbit 208
- regular saddle 330
- Reidemeister 147
 - moves 147, 149, 195
- rejection criteria 269
- relative rotation rates 15, 139, 159, 207, 227, 230, 244, 256, 262, 278
 - and linking numbers 169
 - computation of 160
 - definition 160
 - systematics of 164
- relaxation frequency 309, 311
- representation labels 440, 451
- representation theory 438
 - of groups 194
 - of templates 194
- representations 541
- repère mobile 445
- resonance tongues 475
- return map 131, 263, 316, 459
 - cusp 472
 - first 229
 - p th 229, 260
 - singular 499, 504
- reverse horseshoe 84, 311, 318, 334
- Riemann sheets 508
- right hand convention 147
- right hand rule 147
- rigidity 144–145, 462
- ring laser 343
- RLC circuit 109
- robust 16, 219, 377
- rotation group 502
- rotation interval 100
- rotation number 97
- rotation symmetry 248, 394
 - covers 400
- round-off 238
- routes to chaos 377, 502
- Rössler 113, 498, 505
- Rössler attractor 391, 507
- Rössler dynamical system 400, 405
 - branched manifold 186
 - triple cover 506
- Rössler equations 114, 392, 504
 - bifurcation set 128
 - change of variables 122
 - fixed points 128
- Rössler mechanism 353
- s**
- S^1 502
- saddle
 - flip 330
 - regular 330
- saddle-node bifurcation 9
- Saltzman 112, 338
- samples/cycle 235
- sampling rate 235
- saturation, of fractal dimensions 547
- scalar 234, 243
- scroll 301
- scroll and squeeze 190
- scroll dynamics 393
- scroll template 302, 311, 320, 331, 363, 377, 412
- selection rules 11
- self-consistency check 232
- self-intersections 250, 255, 561
- self-linking number 147
- self-similar 1, 137
- semiflow 182, 184, 210
- semisimple 503
- sensitivity to initial conditions 1, 36–37, 113, 137, 338
- Shannon 219
- Shaw 192
- shear 142
- shift operator 44
- shifts
 - finite type 59, 61
 - full 60
- Shimizu–Morioka
 - attractor 343
 - equations 217, 343
- shrinking 137
- signal-to-noise 12
 - ratio 237, 247, 250, 275
- signed crossings 147
- simple 503
- simple germs 361
- simplicial spaces 483
- simply connected 508
- simulation 269
- singular mapping 465
- singular return maps 499, 504, 506
- singular-value decomposition 117, 233, 252, 267, 283, 295, 338
- singularity 17, 118, 246, 358, 426
 - in maps 464
 - joining 427
 - Lagrangian 504
 - nonlocal 459, 475
 - of branched manifolds 211
 - of maps 459, 499

- rank 501
- “smile” 476
- splitting 427
- singularity theory 18, 468, 493
- skeleton, of trinion 452
- Smale horseshoe 15, 141, 163, 334, 403, 412, 508
 - mechanism 186, 271
 - template 281, 292, 297, 309, 317, 401
- smile singularity 476
- smoothing, data 237
- snake 412
 - diagram 418
- $SO(2)$ 502
- $SO(3)$ 507
- spatial mode 252
- sphere 479
- spike train 329
- spikes 157, 329, 333, 335
 - and writhe 333
- spiral template 362
- splitting points 182, 211, 341, 462, 496
 - and stretching 180
- splitting singularity 427
- spring
 - constant 107
 - force 108
 - nonideal 107
- square root 16, 240, 508
 - of dynamics 418
 - of intensity 350
 - of K–G equation 113
- square, of Rössler dynamics 189
- squeezing 137, 179, 232, 501
 - and branch lines 180
- squeezing mechanism 1, 211
- squeezing unit 433
- stability 507
 - matrix 358
 - of fixed points 130, 133
- standard form, for branched manifolds 200
- standard representation
 - branched manifold 186, 188
 - of link 148
- state variables 105
- stationarity 562
- stationary 237, 239
- statistical tests 258
- statistics 559
- stiff, equations 299
- stochastic differential equations 117
- strands 149
- strange attractor
 - classification of 178
 - hyperbolic 185
- stream function 112, 337
- stretch 335
- stretch and fold 141, 153, 189, 271, 297, 420
 - iterated 142
- stretch-and-fold mechanism 334
- stretch and roll mechanism 334
- stretch-and-roll mechanism 271, 335
- stretch factor 322
- stretching 178, 232, 501
- stretching and squeezing 12, 137, 503
 - mechanisms 139, 141, 178
- stretching mechanism 1
- stretching, and splitting points 180
- stringed instrument 288
 - dynamical tests 291
- stroboscopic sampling 5
- strongly contracting 185
- structurally stable 85, 185
- structure theory 497
 - differential equations 124
- $SU(2)$ 507
- $SU(n)$ 503
- subharmonic windows 311, 317
- subharmonics 9, 311
- subshift 60
- subtemplates 216–217, 298, 320
 - and tongues 222
 - of horseshoe 221
 - of scroll template 320
- subthreshold oscillations 328
- superstable 27
- surface homeomorphisms 378
- surface integral 136
- surface of section 210
- surrogate 259, 376
- surrogate orbits 257, 278
- surrogates 229–230, 232, 256, 262
- SVD 253, 267
 - embeddings 254, 295–296
 - projection 252
- symbol conjugation 202
- symbol name 171
- symbol sequence 202, 229, 261, 264
- symbol space 261
- symbolic
 - dynamics 139, 202, 260, 265, 524
 - encoding 154
 - names 250
- symbols 260

- symmetry 118, 248, 391
 - breaking 508
 - embeddings with 248
 - group 393
 - in strange attractors 347
 - inversion 248, 407
 - reduction of 408
 - restoration 508
 - rotation 248, 394
- symplectic flows 497
- synchronization 234, 334, 509
 - phase 334
- synchronize 511
- syzygy 393–394, 408

- t**
- tangent 445
- Taylor series 135
- Taylor tail 360
- tear and squeeze 188, 420
- tearing 16, 338, 341
 - mechanism 337
 - unit 433
- tears, unfolding of 363
- temperature field 111
- template 15, 175–176, 227
 - as topological invariant 219
 - identification 232, 263
 - matrix 310, 317
 - unroll the scroll 320
 - validation 264
- temporal mode 252
- tesselation 423
- test for chaos 258
 - dynamical 227
 - metric 227
- test for embeddings
 - determinism 548
 - false near neighbors 553
 - FNN 553
 - geometric 550
 - prediction 548
 - topological 548, 555
- theorem
 - Ado 124
 - Alexander's 148
 - Birman–Williams 181
 - divergence 136
 - existence and uniqueness 106
 - implicit function 358
 - Noether 394
- thermal conduction 111
 - coefficient of 111
- thermal expansion 111
 - coefficient of 111
- thermal instability 352
- thinking the unthinkable 233
- Thom lemma 358
- threshold 232
- time delay 249
 - embedding 249
- time domain 234, 236
- time series 15, 229, 234, 243
- tongues 473
- tongues on tongues 475
- toothpaste 462
- topological analysis program 227
- topological entropy 39, 63, 215, 250, 282, 371, 382
 - and branched manifolds 213, 219
 - and channel capacity 220
- topological index 250, 349, 401, 403, 418
- topological invariants 11, 141, 177, 201, 230–231, 233, 250, 278
- topological matrix 180, 187–188, 200, 230, 263
- topological organization 107, 262
- topological period 208
- topologically transitive 37
- topology of forcing 368
 - flows 366
 - maps 365
- toroidal presentation 442
- toroidal representation 442
- torsion, local 155
- torus 106, 131, 231, 244, 256, 262, 354, 462, 479
- torus knots 171, 173, 371
- $T_{p,q,r}$ 361
- trajectory 107
- transform
 - and interpolate 242
 - Hilbert 240
- transients 19, 186, 188, 299, 434
- transition matrix 61, 231, 263–264, 430, 432
- transitivity 368
- translation group 502
- transmission channel 219
- transversality 127, 145, 254
- transverse 85
- trapping boundary 494
- trapping surface 423
- trefoil knot 148
- triangulations 483
- trinions 427, 451
- truncation 238

twist 156, 331
 twisted horseshoe 84
 twisting number 156
 two-dimensional entropy 371
 two-level atom 298

u

U-sequence 292, 368, 371
 – order 293
 ultimately periodic orbits 183
 umbilic series 361
 umbilics 491, 501, 503
 – universal perturbations of 361
 unfolding 16, 357, 359, 361–362, 500
 – an attractor 185
 – coefficients 359
 – global 185
 – local 185
 – Lorenz branched manifold 364
 – of branched manifold 377
 – of folds 362
 – of horseshoe branched manifold 365
 – of tears 363
 – parameters 359, 361
 – universal 359
 – variables 500
 unimodal 21, 54
 unimodal germ 361
 unimodal map 58
 uniqueness theorem 106, 250, 255, 367
 universal
 – covering group 508
 – perturbation 361, 500
 – scaling ratios 9
 – sequence 58, 172, 366
 – unfolding 359, 361
 unstable invariant manifold 180
 unstable manifold 228

v

validate model 228
 validation 234
 – qualitative 269
 – quantitative 269
 van der Pol attractor, template for 192

van der Pol equations 109, 192
 – perestroika 415
 – symmetry of 118
 van der Pol mechanism 159
 van der Pol oscillator 142, 392, 413, 439
 – symmetry of 407

variability

– secular 238
variables

– change of 120
 – germ 500
 – unfolding 500

vector field 119

velocity field 111, 337

viscosity 111

vocabulary 216

voltage 109

volume

– contraction 136
 – expansion 136
 – integral 136

vortex tubes 145

w

well-ordered orbits 371
 Whitney's theorem 507
 winding number 222
 windows 475
 words 216
 writhe 156, 333, 335, 454
 – and spikes 333
 writhe-twist exchange 195
 writhing number 156

y

YAG laser 298, 308, 362
 Young partition 497, 501
 Young's modulus 289

z

Zeeman 477
 zero crossings 244, 548
 zero-entropy orbits 371
 zero-modal 505
 zip code 202
 zip up 426