

Index

- abscissa
 - absolute conv., 393
 - conditional conv., 393
- accelerator mode, 490
- action, 331, 591, 604, 614
 - helium, 672
 - relation to period, 679
- adjacency matrix, 273, 293, *see* transition matrix
- admissible
 - periodic points, 290
 - trajectories, number of, 286
- Airy
 - equation, 597
 - function, 597
- Airy function, 598, 661, 664, 669
 - at a bifurcation, 599
- Airy integral, 597
- algebra, 753
 - associative, 753
 - Lie, 753
- allowable itinerary, *see* admissible
- alphabet, 204
- alternating binary tree, 222
- analyticity
 - domain, 362
- anomalous diffusion, 498
- Anosov flows, 244
- anti-hermitian
 - generator, 171, 172
- antiharmonic extension, 775
- arc, 275
- area preserving
 - Hénon map, 125
 - map, 829
- Artin-Mazur zeta function, 296
- associative algebra, 753
- attractor
 - basin, 41
 - Hénon, 346
 - strange, 41, 46, 340
- Aubry-Mather theory, 572
- autonomous flow, 43
- average
 - chaotic, 471
 - space, 318, 333
 - time, 318, 331
- averaging, 29
- Axiom A, 447, 454
- baker's map, 138, 236
- Balmer spectrum, 580
- basin of attraction, 41
- basis vector, 752
- BER
 - approximation, 482
- Bernoulli, 732
 - polynomials, 434
 - shift, 213, 429, 434, 442, 453, 455, 462, 480, 497, 735, 736, 882, 939
 - shift eigenfunctions, 449
 - shift return times, 480
- Berry-Keating conjecture, 747
- Bessel function, 652
 - addition theorem, 654
- bi-infinite itinerary, 219
- bifurcation
 - Airy function approximation, 599
 - bizarre, 775
 - generic, 138
 - Hopf, 526
 - saddle-node, 66
- billiard, 133–138
 - map, 134
 - stability, 99, 135
 - stadium, 133, 139, 161, 483, 827, 830, 865
- billiards, 925
- binary
 - prime cycles, 233, 242, 290
 - symbolic dynamics
 - collinear helium, 675
 - tree, alternating, 222
- Birkhoff
 - coordinates, 58, 134, 139
 - ergodic theorem, 319
- Birkhoff coordinates, 925
- block
 - finite sequence, 219
- block, pruning, 221

Bohr
 – de Broglie picture, 580
 – Sommerfeld quantization, 580, 631, 743
 helium, 671, 681
 Uetli Schwur, 743
Bohr-Sommerfeld quantization, 598
Boltzmann
 equation, 24, 501
 stosszahlansatz, 24
Boltzmann, L., 24, 734
boredom, 712, 859
Borges, J.L., 712
boundary orbits, 407
bounded operators, 845
Bourbaki, N., 65
Bowen, R., 31
brain, rat, 5, 32
branch cut, 466
 singularity, 467
Bunimovich
 stadium, *see* stadium billiard
Burnett coefficient, 495
butterfly effect, 66
 $C_{3v} = D_3$ symmetry, 242, 411
canonical transformation, 123, 124, 763
Cartan, É. , 192
Cartwright, M.L., 161, 735
Cauchy criterion, 843
caustic, 608
ceiling function, 360, 454
center, 76
center manifold, 519
center of mass, 267
centralizer, 148
chain rule
 matrix, 841
change
 of coordinates, 106
chaology, *see* chaos
chaos, 7, 9
 caveats, 10
 deterministic, 30
 diagnostics, 48
 quantum, 31
 skeleton of, 13, 14
 spatiotemporal, 508
 successes, 10
character
 representation, 810
characteristic
 equation, 758
 exponent, 77, 97
 function, 311
 polynomial, 292, 759, 811
 value, 77
chicken heart palpitations, 7
circle map, 213, 276, 307, 492, 498, 526–528, 533, 540, 543, 710, 879, 1003, 1009
 critical, 529, 534
class, 146
class algebra, 829
Clebsch-Gordan
 coefficients, 755
co-moving frame, 99
coarse-graining, 311
coding, *see* symbolic dynamics
collinear helium, 582
 symbolic dynamics, 675
combinatorics
 teaching, 214
compact
 group, 150
 invariant set, 147
complete
 N -ary dynamics, 275
 symbolic dynamics, 275
completeness
 relation, 78, 754, 759, 812
complex eigenvalues, 79, 766, 993
complex Lorenz flow, 166, 194
 equivariance, 174
 relative periodic orbit, 178
complexity
 algorithmic, 305
confession
 C.N. Yang, 317
 Kepler, 732
 St. Augustine, 311
configuration space, 48
conjugacy, 108
 invariant, 116
 smooth, 106, 116, 118, 923
 topological, 215
conjugate, hermitian, 808
connection formulas, 597
connection, method of, 192
conservation
 equation, 550
 phase space volume, 122, 124, 125, 128, 323
continuity equation, 321, 323, 550, 553, 606
contour integral, 368
contracting
 Floquet multipliers, 97, 351
 flow, 41, 46, 85

- map, 91, 224
- state space, Rössler, 91, 398
- contraction
 - state space
 - Rössler, 918
- convergence
 - abscissa of, 393
 - mediocre, 837
 - radius, 362
 - super-exponential, 439, 560
- convexity, 345
- coordinate
 - change, 106, 108, 921
 - longitudinal, 616
 - transformations, 118
- Copenhagen School, xi, 743
- correlation
 - decay
 - power law, 460
 - function, 449
 - spectrum, 449
 - time, 424
- coset, 146
- cost function, 561
- covariant Lyapunov vector, 95
- covering
 - symbolic dynamics, 219
- creeping
 - 1-disk, 662
- critical
 - point, 98, 211, 216, *see* equilibrium point
 - value, 212, 492
- cross-section, 181, 192
- cumulant
 - expansion, 291, 295, 383
 - Plemelj-Smithies, 849
- curvature
 - correction, 380
 - expansion, 28, 380
- cycle, *see* periodic orbit
 - expansion, 19, 380, 630
 - 3-disk, 396
 - finite subshift, 388
 - Lyapunov exponent, 388
 - stability ordered, 389
 - fundamental, 292, 380, 835
 - limit, 340
 - Lyapunov exponent, 97
 - marginal stability, 72, 100, 180
 - prime, 220, 252, 306, 353
 - 3-disk, 252, 570
 - Hénon map, 563
 - pruning, 303
- Rössler flow, 255, 266
- stability, 94–102
 - Gauss map, 537
- stable, 98
- superstable, 98
- weight, 365
- cycle point, *see* periodic point
- cyclic
 - group, 805, 806
 - invariance, 252
 - symmetry, 288
- cyclist
 - Lie groups, 172
- damped Newton method, 257
- Danish pastry, *see* symbol plane
- danish pastry, 237
- de Broglie wavelength, 600
- Debye approximation, 669
- decay
 - rate, 372
 - rate of correlations, 449
- decomposition
 - irreducible, 814
- defining
 - rep, 808
 - vector space, 807
- degenerate
 - eigenvalues, 757
- degree of freedom, 10, 121, 523, 592
- delta function, *see* Dirac delta
 - Dirac, 587, 949, 978
- density, 311, 550
 - evolution, 24
 - phase space, 323
- density of states
 - average, 626
 - Green's function, 588
 - quantum, 588
- desymmetrization
 - 3-disk, 415, 961
 - state space, 181
- determinant
 - for flows, 364
 - Fredholm, 852
 - graph, 305
 - Hadamard, 362
 - spectral, 23, 291, 362
 - trace relation, 291
 - trace-class operator, 846
- deterministic dynamics, 7, 38, 320
- diagonalizing matrix, 811
- differential equations
 - almost ordinary, 50
 - ordinary

- almost, 914
- diffraction
 - Green's function, 696
 - Keller, 704
 - Sommerfeld, 704
- diffusion
 - anomalous, 498
 - constant, 335
 - equation, 551
 - limited aggregates, 32
- digraph, *see* transition graph
- dihedral group, 805, 806
- dike map, 217, 224
- dimension
 - box counting, 862
 - fractal, 862
 - generalized, 11
 - information, 862, 863
 - intrinsic, 10, 523
- Dirac delta, 21, 23, 297, 313, 326, 338, 353, 360, 373, 443, 551
 - derivatives, 327
 - Jacobian, 321
- Dirac delta function, 589, 609, 621, 949, 978
- Dirac path integral, 620
- Dirichlet series, 392
- discrete
 - Fourier transform, 819
- dissipative
 - map, 91, 224
- divergence rate
 - local, 343
- divergence ultraviolet, 628
- DLA, 32
- dof, *see* degree of freedom
- dot product, 170
- doubling map, 213, 445
- drift, along group tangent, 168
- dual
 - rep, 752, 807, 808
 - space, 752, 807
 - vector space, 807
- Duffing oscillator, 43, 48, 58, 121
- dynamical
 - system
 - gradient, 914
 - transitivity, 273
 - zeta function, 18, 366
 - Euler product rep., 366
- dynamical system, 37, 38
 - equivalent, 117
 - gradient, 50
 - infinite, 524
 - smooth, 20, 21, 28, 39, 299, 735, 882, 885, 887
- dynamics
 - deterministic, 7, 38
 - hyperbolic, 275
 - irreversible, 42
 - reversible, 42
 - spatiotemporal, 31
 - stochastic, 7
 - symbolic, 12, 203, 218
 - symmetry, 144, 166
 - topological, 203, 218, 220, 274
- edge, 275
- eigendirection, 71
- eigenfunction
 - Perron-Frobenius operator, 432
 - energy, 585
 - Perron-Frobenius, 432
- eigenstate, *see* eigenfunction
- eigenvalue, 372
 - Perron-Frobenius operator, 432
 - complex, 79, 766
 - degenerate, 757
 - exponential spacing, 363
 - zero, 598, 613
- eigenvalues
 - complex, 993
- Einstein
 - diffusion formula, 552
- Einstein, A, 747
- elastic
 - scattering, 637
- elliptic
 - stability, 126
- enemy
 - thy, 462
- English
 - plain, 191, 219
- ensemble
 - microcanonical, 345
- entire function, 432
- entropy
 - barrier, 395
 - Gauss map, 544
 - Kolmogorov, 138, 305, 857, 859, 864, 865, 913, 967
 - topological, 8, 286, 297, 305
- equation
 - of variations, 70
- equilibria
 - Kuramoto-Sivashinsky, 515
- equilibrium, 175
 - Lorenz flow, 44, 60
 - point, 43, 80, 317, 516, 563

- Rössler flow, 46, 50, 80, 207
- Rössler system, 915
- relative, 175
- stability, 921
- equilibrium measure, *see* natural measure
- equivalence
 - of dynamical systems, 117
- equivariance, 144
 - complex Lorenz flow, 174
- equivariant, *see* relative
- ergodic
 - average, 319
 - theorem
 - multiplicative, 345
 - theory, 319
- error correlation matrix, 757
- escape rate, 14, 15, 327, 336, 337, 368, 370, 375, 384, 388, 396, 421, 428, 435, 455, 553, 802, 834, 859, 863, 864, 913, 952, 955, 958, 967, 998, 1001
 - 3-disk, 387, 396, 419
 - intermittency, 470
 - vanishing, 327, 386, 773
- essential
 - spectral radius, 442, 451
 - spectrum, 441
- Euler
 - formula, 74, 434, 964
 - limit, 83
 - MacLaurin formula, 449
 - product, 83, 370
 - product rep.
 - dynamical zeta function, 366
 - totient function, 530
- Eulerian coordinates, 72
- evolution
 - group, 50, 914
 - kernel probabilistic, 320
 - operator, 21, 339
 - quantum, 587
 - semigroup, 339
- expanding
 - Floquet multipliers, 97, 351
- expectation value, 333, 346
- exponent
 - characteristic, 97
 - Floquet, 97
- exponential
 - convergence, 362, 439
 - decay rate of correlations, 449
 - of a matrix, 75
 - proliferation, 22, 305
- extremal point, 593
- factor group, 146
- false zeros, 370
- Farey
 - map, 206, 460, 482
 - mediant, 531
 - series, 529
 - tree, 531
- Feigenbaum
 - constant, 360
- Feynman path integral, 612, 620
- Fick law, 551
- finite group, 805
- finite subshift
 - cycle expansion, 388
- first return time, 54, 479
- fixed point, 252
 - maps, 67
 - marginally stable, 460
 - under G , 148, 150
- fixed-point subspace, 148
- Floquet
 - exponent, 85, 97, 125
 - multiplier, 77, 84, 95, 97, 227, 351
 - multiplier, metric invariant, 115
 - theorem, 96
 - theory, 97, 103
 - vector, 95
- flow, 37–47
 - autonomous, 43
 - contracting, 41, 46, 85
 - deterministic, 320
 - elliptic, 98
 - generator of, 321, 786
 - Hamiltonian, 121, 829
 - hyperbolic, 98, 126, 372
 - incompressible, 85, 323
 - infinite-dimensional, 507–524
 - invariant subspace, 149
 - inverse hyperbolic, 126
 - linear, 73, 89
 - linearized, 71
 - nonhyperbolic, 98
 - spectral determinant, 364
 - stability, 79
 - stationary, 43
 - stochastic, 320
 - stretch & fold, 211
- Fokker-Planck equation, 553
- form, normal, 114
- Fourier
 - mode
 - truncation, 510
- Fourier transform
 - discrete, 819

- Fréchet derivative, 71
- fractal, 32, 860
 - aggregates, 11
 - dimension, 862
 - geometry of nature, 11
 - probabilistic, 11
 - science, 11
- Fredholm
 - determinant, 852
- Fredholm theory, 439, 440
- Frenkel-Kontorova model, 572
- frequency analysis, 48
- Fresnel integral, 593, 598
- full shift, 275
- function
 - L^2 square-integrable, 451
 - analytic, 450
 - space, piecewise constant, 354
- functional, 318
 - composition, 42
 - Lyapunov, 41
- fundamental
 - cycle, 292
 - cycles, 835
 - domain, 242
 - collinear helium, 674
 - matrix, 71, 755
- fundamental matrix, 790
- G -equivariant, 169
- G -fixed, 148, 150
- G -invariant
 - basis, *see* invariant polynomial basis
 - polynomial basis, 150, 186
- G -invariant
 - polynomial basis, 149, 161, 162, 192
- G_p -symmetric, 151
- Galerkin truncation, 512
- Galilean invariance, 510, 524
- Gatto Nero
 - professor, 212
- gauge fixing, 60
- Gauss map, 327, 482, 530, 531, 541
 - cycle stability, 537
 - metric entropy, 544
- Gauss shift, *see* Gauss map
- Gaussian
 - integral, 326, 494, 557, 621
 - integral, d -dimensional, 557, 609
 - noise, 892
 - probability density, 552
- generating function, 353, 573
- generating orbit, 223
- generating partition, 220
- generator
 - anti-hermitian, 171, 172
 - Lie algebra, 170
 - of flow, 321, 786
- Gilmore, R., 161
- $GL(n, \mathbb{F})$, 806
- golden mean, 276, 307
 - pruning, 224, 276, 293, 307, 375, 773, 937, 946, 955, 1006
 - renormalization, 533, 542
- good taste, 222
- gradient
 - algorithm, 561
 - system, 50, 914
- grammar
 - symbolic dynamics, 221
- graph
 - irreducible, 275
 - strongly connected, 275
 - transition, 272
- Gray codes, 222
- Green's function, 589
 - analogue of, 790
 - density of states, 588
 - diffraction, 696
 - energy dependent, 587
 - regularized, 628
 - scattering, 643
 - semiclassical, 618, 620, 621
 - short distance, 617, 618
 - trace, 587
 - long orbits, 617
- group, 805
 - S^1 , 805
 - compact, 150
 - cyclic, 805, 806
 - dihedral, 805, 806
 - dynamical, 42
 - evolution, 50, 914
 - finite, 143, 805
 - general linear, 806
 - Lie, 168, 170, 805
 - matrix, 809
 - not a, 830, 997
 - orbit, 147, 159, 169, 175
 - orbit, equilibrium, 195
 - orbit, marginal eigenvalue, 180
 - orbit, reduction, 181
 - orbit, slice, 176, 182, 185, 189
 - orbit, velocity, 761
 - order of, 143, 805
 - representation, 809
 - semi-, 321, 786
 - symmetric, 805
 - tangent field, 170, 174

Gutzwiller
 trace formula, 626
 Gutzwiller path integral, 620
 Gutzwiller, M., 738

Hadamard determinant, 362
 Hadamard product, 629

Hamilton
 -Jacobi equation, 601, 618, 900
 equations, 601
 principal function, 554, 604
 Hamilton-Cayley theorem, 754, 759
 Hamilton-Jacobi equation, 554
 Hamiltonian, 585, 602
 dynamics, 120–129
 flow, 829
 spectral determinant, 366
 stability, 122, 764
 flows, stability, 761
 Hénon map, 125
 repeller, periodic orbits, 267, 942

Hankel function, 617, 652, 669
 harmonic oscillator, 118
 Harter, W. G., 829
 Heaviside function, 588
 Heisenberg, 744
 picture, 843
 Heisenberg, W, 785
 Helfand moments, 494
 helium, 671, 743
 collinear, 51, 67, 122, 582, 690, 916
 cycles, 267, 690
 eigenenergies, 691
 fundamental domain, 674
 Poincaré section, 690
 stabilities, 690
 stability, 267

Helmholtz equation, 652
 Hénon map, 64, 66, 126
 attractor, 320, 346
 cycles, 267, 561
 fixed points, 67, 234
 Hamiltonian, 125
 horseshoe, 234
 inverse, 234
 Lyapunov exponent, 346, 953
 natural measure, 316
 prime cycles, 563, 574
 pruning, 838
 pruning front, 245
 stability, 87, 98
 structural stability, 246
 symmetries, 829
 time delay map, 260
 transient, 563

Hénon, M., 66
 Hénon-Heiles
 symbolic dynamics, 161

hermitian
 conjugation, 808
 matrix, 808

heroes
 unsung, xi, xvi

Hessian matrix, 123
 heteroclinic orbit, 208, 214, 223

Hilbert
 basis, *see* invariant polynomial basis
 space, 586

Hilbert basis
 SO(2), 187

Hilbert-Schmidt
 operators, 845

Hilbert-Schmidt condition, 440
 Hilbert-Weyl theorem, 150

Holmes, P., 523
 homoclinic orbit, 208

Hopf
 bifurcation, 526
 Hopf's last hope, 741
 Hopf, E., 739, 740
 Hopf, Ebehardt, 526
 Hopf, Heinz, 688
 hopping operator, 815
 horseshoe, 233
 complete, 236

hydrodynamical
 interpretation of QM, 620

hyperbolic
 flow, 98, 126, 372
 non-, 25
 orbit, partially, 98

hyperbolicity assumption, 17, 352

image space, 181, 187
 in/out nodes, 76
 inadmissible symbol sequence, 220
 incommensurate, 40
 incompressible flow, 85
 indecomposability, 273
 metric, 205

index
 Maslov, *see* topological index
 index summation, repeated, 806

indifferent
 stability, 71

induced map, 474
 inertial manifold, 511, 523
 infinite-dimensional flows, 507–524
 inflection point, 527
 information

- dimension, 862
- information dimension, 863
- initial
 - conditions, sensitivity to, 8
 - point x_0 , 16, 39, 71
 - state x_0 , 16, 39
- injective, 65
- integrable system, 105, 122
- integrated observable, 331, 332, 339, 343, 353, 367, 379, 836
- integration
 - Runge-Kutta, 50
- integration by parts
 - lattice, 816
- intermittency, 138, 445, 459
 - escape rate, 470
 - piecewise linear model, 462
 - resummation, 476
 - stability ordering, 391
- invariance
 - cyclic, 252
 - Galilean, 510, 524
 - of flows, 100
 - symplectic, 123, 129, 761
- invariant, 809
 - density, *see* natural measure
 - matrix, 808
 - measure, 317
 - measure, Gauss map, 327
 - metric, 95, 116
 - points, 148
 - polynomial basis, 149, 150, 161, 162, 181, 186–189, 192
 - polynomials, 926
 - set, compact, 147
 - subgroup, 146
 - subspace, 149
 - tensor, 173
 - topological, 95
 - tori, 190
 - vector, 808
- inverse
 - hyperbolic, 96, 126
 - iteration, 256
 - iteration, Hamiltonian repeller, 267, 942
- inversion, 143
- involution, 806
- inward/outward spirals, 76
- irreducible
 - decomposition, 814
 - graph, 275
 - matrix, 273
 - segment, 154
- irrep, 814
- irreversibility, 24, 42
- Ising model, 241, 410, 415, 870, 872, 883, 884, 889, 890
- isotropy, 148, 150, 159, 160
- isotypic decomposition, 160
- iteration, 39
 - inverse, 256
 - Hamiltonian repeller, 267, 942
 - map, 63
- itinerary, 12, 14, 58, 204, 253
 - bi-infinite, 206, 219
 - future, 212, 218
 - past, 219
- Jacobi, C.G.J., 89
- Jacobian, 84, 312
 - matrix, 16, 71, 756
- Jonquière function, 464, 483, 499, 500, 503
- Jordan form, 758
- Jordan normal form, 760
- KAM
 - tori, 459
- Karhunen-Loève, 231
- Keller
 - diffraction, 704
- Keller, J.B., 738
- Keplerian orbit, 580
- kernel
 - resolving, 440
- kneading
 - determinant, 223
 - sequence, 216, 224
 - theory, 216
 - value, 216, 224
- Kolmogorov entropy, 138, 305, 857, 859, 864, 865, 913, 967
- Koopman operator, 785, 790
- Kraichnan, R., 740
- Kramers, 744
- Krein-Friedel-Lloyd formula, 644
- Kronecker delta, 752, 807
- KS, *see* Kustaanheimo-Stiefel
- Kuramoto, Y., 523
- Kuramoto-Sivashinsky
 - equilibria, 515, 518
 - system, 513, 516, 519, 523
- kurtosis, 346, 494
- Kustaanheimo-Stiefel transformation, 111, 672
- L^2 function space, 451
- Lagrangian, 604

- coordinates, 72
- frame, 99
- manifold, 605
- laminar states, 459
- Langevin equation, 552, 556
- Laplace
 - transform, 23, 297, 322, 355, 356, 360, 587, 618, 787
 - transform, discrete, 290, 353, 481
- Laplace, Pierre-Simon de, 6
- Laplacian
 - diagonalization, 831
 - diagonalized, lattice, 821
 - inverse, lattice, 817
 - lattice, 816
 - non-local, 831
- last hope, Hopf's, 741
- lattice
 - derivative, 815
 - Fourier transform, 819
 - integration by parts, 816
 - Laplacian, 816
 - Laplacian, diagonalized, 821
 - Laplacian, inverse, 817
- least action principle, 252, 570
- Legendre transform, 604
- Leibniz, Gottfried Wilhelm, 6
- Letellier, C., 161
- level set, 121
- libration orbit, 677, *see* self-retracing
- Lie
 - algebra, 170, 173, 753
 - bracket, 174
 - derivative, 174
 - group, 168, 170, 805
 - product, 753
- lifetime, 15
- lifetime matrix, 647
- limit
 - cycle, 340
- limit cycle
 - stability, 921
- linear
 - flow, 73, 89
 - space, 751
 - stability, 69, 94, 516
- linearized
 - flow, 71
- link, 275
- Liouville
 - equation, 323
 - operator, 324
 - theorem, 122, 124, 125, 128, 323
- Littlewood, J.E., 735
- local
 - divergence rate, 343
 - stability, 69, 94, 516
- logistic map, *see* unimodal
- longitudinal
 - coordinate, 616
- loop
 - intersecting, 292
- Lorentz gas, 459, 482
- Lorentzian, 589, 978
- Lorenz flow, 44, 60, 81, 83, 85, 152, 155, 163, 208, 926, 997
 - complex, *see* complex Lorenz flow
 - polar coordinates, 162, 830
 - proto-Lorenz, 163, 926
 - symmetry, 145, 162
- Lorenz, E.N., 66, 161
- loxodromic, 764
 - quartet, 125, 130
- Lozi map, 65, 66
- Lyapunov
 - covariant vector, 95
 - exponent, 8, 85, 117, 340
 - exponent, cycle, 97
 - exponent, cycle expansion, 388
 - exponent, equilibrium, 516
 - exponent, natural measure, 343
 - exponent, numerical, 345
 - exponent, numerically, 342
 - functional, 41
 - time, 8, 10, 25, 42, 331
- \mathcal{M} state space volume, 336
- manifold
 - unstable, 228
- map, 39, 62–65
 - area preserving, 829
 - contracting, 91, 224
 - dike, 217, 224
 - dissipative, 91, 224
 - expanding, 206
 - fixed point, 67
 - Hénon, 64, 561, 829
 - Hamiltonian, 125
 - prime cycles, 563
 - Hamiltonian
 - Hénon, 125
 - iteration, 63
 - logistic, *see* unimodal
 - Lozi, 65, 66
 - once-folding, 233
 - order preserving, 215
 - orientation preserving, 829
 - orientation reversing, 829
 - quadratic, 65

- return, 16, 54–56, 58, 207, 208, 218, 230, 234
- sawtooth, 145, 151, 401
- stability, 86
- stroboscopic, 921
- tent, 211
- unimodal, 211
- marginal
 - stability, 16, 71, 97, 180, 351, 445, 460
 - cycle, 72, 100, 180
 - fixed point, 460
- Markov
 - chain, 219
 - graph, *see* transition graph
 - matrix, 273, 314, 388
 - partition, 495
 - finite, 206, 275
 - infinite, 282
 - not unique, 228
- Maslov index, *see* topological index
- material invariant, 550
- Mather, *see* Aubry-Mather theory
- matrix
 - diagonalizing, 811
 - exponential, 75, 788
 - group, 809
 - hermitian, 808
 - invariant, 808
 - irreducible, 273
 - of variations, *see* stability matrix
 - product, 753
 - rep, 753
 - stability, 70, 554
- matrix representation, 144
- Maupertuis, P.L.M. de, 252, 570
- measure, 311
 - continuous, 117
 - invariant, 317
 - natural, 66, 318, 325, 333, 425, 427, 486, 740, 746
- mechanics
 - quantum, 585
 - statistical, 24
- mediocre
 - convergence, 837
- memory
 - m*-step, 204
 - finite, 277
- method of connections, 192
- metric
 - indecomposability, 205, 839
 - invariant, 95, 116
 - Floquet multiplier, 115
 - transitivity, 839
- metric entropy
 - Gauss map, 544
- microcanonical ensemble, 345
- Mira, C., 66
- Misiurewicz, M., 66
- mixing, 8, 9, 17, 319
- mode
 - normal, 830
- Moebius inversion, 302
- monodromy matrix, 86, 101, 351, 763
- Morse index, *see* topological index
- moving frame, 181, 182
 - SO(2), 183
- multi-scattering matrix, 655
- multifractals, 879
- multiplicative ergodic theorem, 345
- multiplier
 - Floquet, 77, 97, 227
- multipoint shooting method, 258
- N*-disk
 - transition matrix, 275
- natural density, *see* natural measure
- natural invariant, *see* natural measure
- natural measure, 66, 264, 318, 325, 333, 343, 425, 427, 448, 486, 740, 746
- nature
 - geometry of, 11
- Navier-Stokes equation, 507
- neighborhood, 69, 102
- Nero, G., 212
- neutral, *see* marginal
- New York subway map, 228
- Newton method, 257
 - convergence, 257
 - damped, 257
 - flows, 260
 - optimal surface of section, 769
- Newtonian dynamics, 120
- node, 275
- noise
 - Gaussian, 552, 555, 892
 - white, 552
- non-wandering set, 41, 235
- nonequilibrium, 486
- nonhyperbolic
 - flow, 98, 100
- norm, 843
- normal
 - divisor, 146
 - form, 114
 - mode, 830
 - washing machine, 143

normal modes, 997
 obscure
 foundations, 743
 jargon, 191, 203
 topology, 513, 518
 observable, 318, 325, 331, 351, 424, 471, 479, 486, 498, 738, 785, 867, 872, 889, 890
 integrated, 331, 332, 339, 343, 353, 367, 379, 836
 simultaneous, 813
 vector, 346
 ODEs, 507
 $O(n)$ group, 805
 1-disk
 creeping, 662
 scattering, 653
 semiclassical scattering, 659
 Onsager-Machlup, 556
 open systems, 14, 335
 operator
 evolution, 339
 Hilbert-Schmidt, 845
 hopping, 815
 just a matrix, 816
 Koopman, 785, 790
 Liouville, 324
 norm, 843
 Perron-Frobenius, 313, 345
 positive, 845
 regularization, 851
 resolvent, 290, 322, 787
 semigroup
 bounded, 322, 787
 shift, 217, 219, 815
 step, 815
 trace-class, 844
 orbit, 39, 63, 147
 inadmissible, 216
 Keplerian, 580
 periodic, 40, 220, 379, 624, 625
 returning, 623
 orbit space, 181
 order preserving map, 215
 ordering
 spatial, 213, 236
 ordinary differential equations, *see* ODEs
 almost, 50, 914
 partial differential equations, 507
 orientation
 preserving map, 829
 reversing map, 829
 orthogonality
 relation, 78, 754, 759, 812
 Oseledec ergodic theorem, 345
 palpitations, chicken heart, 7
 paradise
 this side of, 419
 partial differential equations, *see* PDEs
 partial differential equations, 507
 partially hyperbolic invariant tori, 190
 partially hyperbolic orbit, 98
 partition, 204, 220
 state space, 311
 generating, 220
 infinite, 224, 297, 306
 Markov, 206
 partition function, 344
 passive scalar, 550
 past topological coordinate, 238
 path integral
 stochastic, *see* Wiener integral
 PDEs, 38, 507
 period
 relation to action, 679
 periodic
 orbit, 13, 40, 176, 220, 379, 624, 625
 condition, 251, 264, 560
 extraction, 251–265, 560–570
 Hamiltonian repeller, 267
 inverse iteration, 256
 multipoint shooting, 258
 Newton method, 257
 relative, 177
 relaxation algorithm, 561
 orbit extraction
 Hamiltonian repeller, 942
 orbit, short, 154, 160
 point, 13, 16, 21, 22, 40, 215, 220, 777
 admissible, 290
 count, 300
 unstable, 14
 periodic orbit
 unstable, 98
 Perron-Frobenius
 matrix, 273
 operator, 313, 345, 432
 theorem, 448, 454, 882
 Peter-Weyl theorem, 168
 phase space, 38, 129, *see* state space
 3-disk, 839
 density, 323
 vs. state space, 48
 piecewise constant function, 354
 piecewise linear map, 482
 intermittency, 462

- repeller, 337
- pinball, *see* 3-disk
 - simulator, 139, 925
- plain English, 191, 219
- plane Couette flow
 - energy, 523
 - relative solutions, 179
 - stability, 761
 - symmetries, 146, 150, 161, 168
 - unstable manifold, 230
- Plemelj-Smithies cumulants, 849
- POD, 231
- Poincaré invariants, 128
- Poincaré return map, 54, 55
 - cycle, 101
 - polynomial, 63
 - stability, 87
- Poincaré section, 13, 54–62, 234
 - 3-disk, 134
 - Hénon trick, 66
 - hyperplane, 56, 230
- Poincaré, H., 5, 9, 15
- point
 - non-wandering, 41
 - periodic, 13, 220
 - scatterer, 705
 - wandering, 40
- point-wise invariant, *see* G -fixed
- Poisson
 - bracket, 174, 323, 324, 326, 762
 - resummation, 23, 477
- polar coordinates, 118
- Pollicott, M., 345, 480
- polylogarithm, 464
- polynomial
 - characteristic, 292
 - topological, 296
- Pomeau, Y., 66
- positive operators, 845
- post-processing, 183, 190
- potential
 - problems, 50
- power law
 - correlation decay, 460
- pressure, 344
 - thermodynamic, 344
- prime cycle, 220, 252, 306, 353
 - 3-disk, 233, 306, 570
 - binary, 233, 242, 290
 - count, 302
 - Hénon map, 563, 574
 - ternary, 242
- primitive cycle, *see* prime cycle
- probabilistic zeta function, 480
- probability
 - density, Gaussian, 552
 - matrix, 273
- product
 - Lie, 753
 - matrix, 753
- profile, spatial, 39
- projection operator, 759, 811, 812, 818, 819
 - complete, orthonormal, 819
- propagator, 587
 - semiclassical, 609
 - short time, 610, 617
 - Van Vleck, 611
- pruning, 12, 460
 - block, 221
 - golden mean, 224, 276, 293, 307, 375, 773, 937, 946, 955, 1006
 - individual cycles, 303
 - primary interval, 217
 - rules, 275
 - symbolic dynamics, 220
- pruning front, 240
 - 3-disk, 206, 247
- pseudocycle, 379
- quadratic map, 65
- quantization
 - Bohr-Sommerfeld, 580
 - semiclassical, 623
 - WKB, 590, 594
- quantum
 - chaos, 583, 629
 - evolution, 587
 - interference, 600
 - mechanics, 585
 - potential, 619
 - propagator, 587
 - resonances, 580
 - theory, old, 743
- quantum chaology, *see* chaos, quantum
- quasiperiodicity, 40
- quotient
 - group, 146
 - state space, 60, 147, 181
- radius
 - of convergence, 362
- random matrix theory, 583
- Rayleigh-Benard flow, 44
- recoding, 221, 233, 241
- rectangle, 237
- rectification
 - flows, 107
 - maps, 113

- recurrence, 41, 203
 - time, *see* return time
- reduced state space, 147, 180, 181
- reducible representation, 168
- reflection, 143
- regular group action, 182
- regularization, 110, 629
 - Green's function, 628
 - operator, 851
- relative
 - equilibrium, 175
 - periodic orbit, 177
 - solutions, 356
- relaxation algorithm, 561
- renormalization, 138
 - golden mean, 533, 542
- rep
 - defining, 808
 - dual, 752, 807, 808
 - matrix, 753
 - standard, 806
- repeated index summation, 806
- repeller, 14, 41, 336, 582
 - piecewise-linear, 337
 - single fixed point, 432
- representation
 - character, 810
 - equivalent, 810
 - faithful, 810
 - linear, 169
 - matrix, 809
 - reducible, 168
 - regular, 810
 - space, 806
- representative point, 38
- residue, 128
 - stability, 126, 130
- resolvent
 - kernel, 440
 - operator, 290, 322, 787
- resonances
 - complex, 582
 - quantum, 580
 - Ruelle-Pollicott, 345, 480
- resummation
 - intermittency, 476
- return map, 16, 56, 58, 234
 - Rössler flow, 207
- return time, 480
 - distribution, 480
- returning orbit, 623
- reversible
 - dynamics, 42
- Riemann zeta function, 392, 482, 499
- Rössler
 - attractor, 58
 - cycles, 255, 266
 - equilibria, 50, 80, 207
 - flow, 45, 48, 50, 58, 67, 91, 342
 - Lyapunov exponent, 346
 - return map, 207
 - web diagram, 218
- Rössler system, 915
 - equilibria, 915
- rotating wave, 175
- Roux, Henri, 30, 85
- Ruelle
 - Pollicott resonances, 345, 480
 - zeta function, *see* dynamical zeta function
- Ruelle, D., 31, 345, 480
- Runge-Kutta integration, 50
- running orbit
 - Lorentz gas, 490
- Rutherford, 671
- Rydberg series, 681
- S^1 group, 805
- saddle, 76
- saddle point, *see* stationary phase
- saddle-node bifurcation, 66
- sausage, $(N+1)$ -dimensional, 168
- sawtooth map, 145, 151, 401
- scalar multiplication, 751
- scattering
 - 3-dimensional spheres, 138
 - elastic, 637
 - Green's function, 643
 - matrix, 638
 - phase shift, 645
 - point, 705
- schmactals, *see* fractal
- Schrödinger
 - equation, 585
 - time independent, 585
 - picture, 843
- Schrödinger, E, 785
- Schwartzian derivative, 117
- section
 - Poincaré, 13, 54, 56, 58, 134
- secular equation, 758, 759, 811
- self-retracing cycle, 677
- self-similar, 22
- semiclassical
 - approximation, 601
 - Green's function, 618, 621
 - propagator, 609
 - quantization, 623
 - spectral determinant

- collinear helium, 683
- wave function, 607
- semiclassical zeta function, 630
- semiclassical resonances
 - 3-disk, 905
- semigroup, 321, 786
 - dynamical, 42
 - evolution, 339
 - operator, 322, 787
- Sensitivity
 - initial conditions, 911
- sensitivity to initial conditions, 8, 34, 66, 340
- set
 - non-wandering, 235
- shadowing, 19, 20, 299
 - 3-disk, 387
- shift, 219
 - Bernoulli, 213, 434, 480, 939
 - finite type, 221
 - full, 219, 275
 - map, 528
 - operator, 217, 219
 - sub-, 220
- shift operator, 815
- short periodic orbit, 154, 160
- similarity transformation, 116
- simultaneous observables, 813
- Sinai, Ya., 31
- Sinai-Bowen-Ruelle measure, *see* natural measure
- single fixed point
 - repeller, 432
 - spectral determinant, 433
- singular value decomposition, 75, 90
- singular values, 76
- singularity
 - branch cut, 467
- Sivashinsky, G.I., 523
- skeleton of chaos, 13, 14
- slice, 181, 182, 192
 - condition, 182
 - linear, 182
- Smale
 - wild idea, 364, 374
- Smale, S., 11, 31, 227, 244, 305, 374, 735
- small divisor problem, 352
- S -matrix, 638
- smooth, 170
 - conjugacy, 106, 115, 116, 118, 923
 - dynamical system, 524
 - dynamics, 20, 21, 28, 39, 299, 735, 882, 885, 887
- approximated, 834
- dynamics, spectral determinant, 453
- interaction, 889
- potential, 138
- $SO(2)$, 170, 183
- $SO(2)$, 80, 118, 168, 172, 174, 187, 194–196, 756
 - irreducible representation, 171
- $SO(3)$, 170, 742
- solution
 - symmetry, 174
- Sommerfeld
 - diffraction, 704
- space
 - analytic functions, 450
 - average, 318
 - averaging, 333
 - configuration, 48
 - defining vector, 807
 - density functions, 354
 - dual, 752, 807
 - linear, 751
 - phase, 48
 - state, 48
 - vector, 751
- span, 752
- spatial profile, 39
- spatiotemporal chaos, 508
- spatiotemporal dynamics, 31
- spectral
 - decomposition, 78, 755, 759, 804, 813
 - determinant, 23, 291, 362
 - 1 – dimensional maps, 365
 - 2–dimensional hyperbolic Hamiltonian flow, 366
 - entire, 363, 439
 - for flows, 364
 - infinite product rep., 364
 - single fixed point, 433
 - weighted, 371
 - spectral determinant
 - 1-dof, 631
 - 2-dof, 632
 - radius, 433, 442
 - essential, 451
 - stability, 498
 - staircase, 588
- spectrum
 - Balmer, 580
- specular reflection, 133
- Spiegel, E.A., 740
- SRB measure, *see* natural measure
- St. Augustine, 311

- stability, 69–89
 - billiards, 99, 135
 - continuous symmetry, 180
 - eigenvalue, *see* Floquet multiplier
 - elliptic, 352
 - exact, 104, 921
 - exponent, *see* Floquet exponent
 - flow, 79
 - Hamiltonian flow, 764
 - Hamiltonian flows, 122, 761
 - indifferent, 71
 - linear, 69, 94, 516
 - maps, 86
 - marginal, 71, 180
 - matrix, 70, 554
 - multiplier, *see* Floquet multiplier
 - neutral, *see* marginal
 - ordering
 - cycle expansions, 389
 - intermittent flows, 391
 - Poincaré map cycle, 101
 - Poincaré return map, 87
 - residue, 126, 130
 - spectral, 498
 - structural, 235, 236, 244, 300, 498
 - window, 98
- stabilizer, 148, 150, 160
- stabilizer subgroup, *see* isotropy subgroup
- stable
 - cycle, 98
 - manifold, 16, 228–230, 234
- stadium billiard, 133, 139, 161, 483, 827, 830, 865
- stagnation point, *see* equilibrium point
- staircase
 - mean eigenvalue density, 684
 - spectral, 588
- standard map, 126, 130, 460
- standard representation space, 806
- standing orbit
 - Lorentz gas, 490
- standing wave, 43, 179
- state, 203, 275
 - set, 204
- state space, 38
 - discretization, 345
 - partition, 311
 - reduced, 147, 180
 - volume \mathcal{M} , 336
 - vs. phase space, 48
- stationary
 - flow, 43
 - phase, 320, 571
 - phase approximation, 593, 598, 611, 624, 696, 705, 983, 984, 988
 - point, *see* equilibrium point
 - state, 317
- stationary phase, 593, 596, 598, 613, 621, 651, 666, 695, 697, 899, 973
- statistical mechanics, 24
- steady state, *see* equilibrium point
- step operator, 815
- Sterling formula, 598
- stochastic
 - dynamics, 7, 320
 - matrix, 273
 - path integral, *see* Wiener integral
- Stokes theorem, 129, 605
- stosszahlansatz, 24, 501
- strange attractor, 41, 46, 340
 - Rössler flow, 58
- stretch & fold, 64, 211
- strobe method, 54
- stroboscopic map, 921
- strongly connected graph, 275
- structural stability, 27, 235, 236, 244, 300, 498, 501, 509, 710, 746
 - Hénon map, 246
- structure constant, 173, 753
- subgroup
 - isotropy, 148
- subshift, 220
 - finite type, 221, 244, 274–276, 278
- $SU(n)$ group, 805
- super-exponential
 - convergence, 560
- superstable cycle, 98
- superstable fixed point, 560
- surface of section
 - optimal, 769
- surjective, 65
- survival probability, 15, *see* escape rate
- symbol
 - sequence
 - inadmissible, 220
 - square, 237
- symbol square, 236
- symbolic dynamics, 12, 203–221, 771–779
 - 3-disk, 34, 206, 247, 926
 - at a bifurcation, 138
 - binary
 - collinear helium, 675
 - coding, 221
 - transition graph, 388
 - complete, 211, 222, 235, 275
 - complete N -ary, 275
 - covering, 219

- grammar, 221
- Hénon-Heiles, 161
- pruned, 220
- recoding, 221, 233, 241
- unimodal, 212
- symmetric group, 805
- symmetry
 - D_3 , 242, 411
 - 3-disk, 155, 158, 242, 411, 415, 961
 - cyclic, 288
 - dynamical system, 144, 166
 - Hénon map, 829
 - solution, 174
 - under G_p , 151
- symmetry, continuous, 166–189
- symmetry, discrete, 142–158, 233, 240
- symplectic
 - form, 123
 - group $Sp(2D)$, 763
 - Hénon map, 125
 - integrator, 789
 - invariance, 123, 129, 761
 - map, 124
 - transformation, 123, 233, 324
- systems
 - open, 335
- syzygy, 149, 162, 187, 188, 926
- tangent
 - bundle, 43, 70
 - field, 170
 - field, group, 174
 - space, 70
- Tauberian theorem, 482
- teaching
 - combinatorics, 214
- template, 207, 256
- tensor
 - invariant, 173
- tent map, 117, 118, 211
- ternary
 - prime cycles, 242
- tessalation
 - smooth dynamics, 834
- thermodynamical
 - pressure, 344
- 3-body problem, 108, 582, 671, 732, 744
- 3-dimensional sphere
 - scattering, 138
- 3-disk
 - boundary orbits, 407
 - convergence, 444, 834
 - cycle
 - analytically, 266
 - count, 159, 413, 784
 - expansion, 396
 - escape rate, 346, 387, 396, 419
 - fractal dimension, 860
 - geometry, 134
 - hyperbolicity, 352
 - phase space, 839
 - pinball, 6, 135, 138
 - point scatterer, 705
 - prime cycles, 18, 233, 252, 306, 570
 - pruning front, 206, 247
 - semiclassical resonances, 905
 - shadowing, 387
 - simulator, 139
 - state space, 14, 58, 860
 - symbolic dynamics, 12, 34, 206, 247, 926
 - symmetry, 155, 158, 242, 411, 415, 961
- time
 - arrow of, 24
 - as parametrization, 107
 - average, 318, 331, 342
 - ceiling function, *see* ceiling function
 - ordered integration, 84, 89
 - turnover, 80, 82, 757
- time delay
 - Wigner, 645
- time- t forward map, 48, 174
- topological
 - conjugacy, 215
 - dynamics, 203, 218, 220, 221, 274
 - entropy, 8, 286, 297
 - future coordinate, 215
 - index, 608
 - topological index, 744
 - invariant, 95
 - Markov chain, 219
 - parameter, 218
 - polynomial, 296
 - trace formula, 290
 - transitivity, 273
 - zeta function, 296, 297
- topological index, 626
- torus, 40
- totient function, 530
- t_p cycle weight, 365
- trace
 - class operators, 656
 - formula
 - classical, 23
 - flows, 355
 - Gutzwiller, 626
 - maps, 353, 433
 - topological, 290, 297

- local, 288
- trace-class operator, 844
 - determinant, 846
- trajectory, 39, 74
 - discrete, 63
- transfer
 - matrix, 314, 337
 - operator, 374
 - spectrum, 363
- transformation
 - canonical, 233
 - coordinate, 118
 - symplectic, 233
- transient, 40, 205, 281
- transition
 - graph, 272–282
 - infinite, 295
 - matrix, 272, 288
 - matrix, N -disk, 275
- transition matrix, 286
- transversality
 - condition, 55
- transverse
 - stability, 617
- traveling wave, 175, *see* relative equilibrium
- Trotter product formula, 843
- truncation
 - Galerkin, 512
- truncations
 - Fourier, 510
- turbulence, 9, 10, 523
 - problem of, 507
- turnback point, 232
- turnover time, 80, 82, 757

- Ulam map, 117, 118, 211, 266, 267
 - skew, 314, 429, 952
 - tent, 327, 376
- ultraviolet divergence, 628
- unimodal
 - kneading value, 224
 - map, 211
 - map, symbolic dynamics, 212
 - well ordered symbols, 224
- unstable
 - cycle, 98
 - manifold, 16, 228–230, 234
 - periodic orbit, 98
 - periodic point, 14
- unsung
 - heroes, xi, xvi
- UPO (Unstable Periodic Orbit), *see* periodic orbit

- van Kampen, N. G., 556

- Van Vleck
 - propagator, 611
- variational principle, 555
- vector
 - basis, 752
 - field, 42
 - field, singularities, 107
 - invariant, 808
 - observable, 346
 - space, 751
 - defining, 807
 - dual, 807
- velocity gradients matrix, 70
- vertex, 275
- visitation frequency, 318
- visitation sequence, *see* itinerary
- volume preservation, 137
- von Neumann
 - ergodicity, 790

- Waleffe, F., 741
- walk, *see* itinerary
- wandering point, 40
- wave
 - standing, 43, 179
- wave function
 - semiclassical, 607
 - WKB, 608
- web diagram
 - Rössler flow, 218
- weight
 - multiplicative, 29
- well ordered symbols
 - unimodal, 224
- Wentzel-Kramers-Brillouin, *see* WKB
- Weyl
 - Peter-Weyl theorem, 168
- Weyl rule, 627
- Weyl, H., 811
- white noise, 552
- Wiener integral, 555
- Wigner delay time, 645
- winding number, 128, 527, 528
- WKB, 590, 601
 - connection formulas, 597
 - quantization, 590, 594
 - wave function, 608

- Yang, C.N., 317
- Young, L.-S., 66

- zero eigenvalue, 598, 613
- zeros
 - false, 370
- zeta function

Artin-Mazur, 296
dynamical, 18, 366
probabilistic , 480
Ruelle, *see* dynamical
topological, 296, 297