

# Index

- additive rule, 19
- ansatz method, 205
- automata rule with memory, 20
- automata rule without memory, 20
- automata rule, additive, 19
- automata rule, legal, 20
- automata rule, peripheral, 20
- automata rule, symmetric, 20
- automata rule, totalistic, 20
  
- BBGKY, 139
- BGK approximation, 144, 145, 165, 195, 205
- binary digit, 153
- bit, 153
- bit-function, 44
- bit-operator, 44
- bit-state, 57
- bitwise, 44
- blood flow, 243
- Boltzmann approximation, 138
- Boltzmann distribution, 141
- bottom friction, 230
- bounce-back rule, 80
- boundary condition, complete
  - bounceback, 189
- boundary condition, half-way
  - bounceback, 190
- boundary conditions, 79
- boundary: link boundary, 189
- boundary: node boundary, 189
- breaking of Galilean invariance, 73
- Burgers equation, 138, 243
- Burnett equations, 146
  
- C (programming language), 44
- cell, 264
- cellular automata, 9, 15
- cellular automata, elementary, 19
- chaining, 47
- Chapman-Enskog expansion, 71
  
- Chapman-Kolmogorov equation, 64
- chessboard, 40
- chessboard instability, 40
- chiral, 53
- coarse graining, 10
- collision, 37, 40, 57
- collision cross section, 140
- collision frequency, 144
- collision integral, 140
- collision invariants, 140
- collision parameter, 182
- color, 137
- complementation, 248
- configuration, 18
- configuration, global, 16
- configuration, local, 16
- conservation laws, 21
- continuity equation, 7
- Coriolis parameter, 220
- crystal growth, 244
- curvilinear coordinates, 243
  
- D1Q4, 136
- D2Q129, 134
- D2Q13-FHP, 101, 205
- D2Q13-WB, 97
- D2Q21, 98, 134
- D2Q25, 134
- D2Q4, 92
- D2Q57, 134
- D2Q7, 94
- D2Q9, 96, 131, 133, 168
- D3Q15, 98, 197
- D3Q19, 101, 129
- D4Q24, 95
- detailed balance, 58
- diagonal pair interaction, 124
- diffusion equation, 21, 136, 236
- diffusion equation, nonlinear, 240, 242
- divergence of transport coefficients in 2D, 137

- DkQb, 92
- droplets, 244
- dual solids, 105
- duality, 249
- dynamic similarity, 9
- dynamical geometry, 137, 243
- eddy viscosity coefficient, 220
- edge, 264
- Ekman number, 229
- electrodynamics, 17, 244
- elementary cellular automata, 19, 23
- energy conservation, 128–130
- energy equation, 205
- ensemble, 64, 65
- entropy, 22
- entropy, maximum entropy principle, 156
- entropy, relative, 171
- entropy, Renyi, 158
- entropy, Shannon, 22, 156
- Euler equation, 74, 121, 177
- evolution operator, 40, 55
- exclusion principle, 40, 53, 113
- face, 112, 264
- FCHC, 10, 66, 68, 95, 109, 113, 118, 129, 134, 265
- Fermi-Dirac, 40, 53, 66, 74, 115
- fermions, 40
- FHP, 94, 115, 129, 242
- FHP-I, 54
- FHP-II, 54
- FHP-III, 54
- finite differences, 10, 232, 245
- finite elements, 10
- finite volumes, 10
- flow in dynamical geometry, 137, 243
- FORTRAN, 44
- fractal obstacles, 243
- friction coefficient, 220
- functional derivative, 157
- g-factor, 73, 78
- Galilean invariance, 90, 169
- Galilei transformation, 73, 78
- Garden of Eden, 22
- generalized lattice tensors, 95, 128
- Gibbs, 121
- Gibbs' ensemble, 64
- glacier flow, 243
- global configuration, 16
- Greek indices, 49, 57
- grid Reynolds number, 227
- H-theorem, 244
- Hénon constraints, 113, 115
- Hénon's random rule for FCHC, 134
- head-on collision, 40, 43
- HPP, 17, 39, 66, 68, 92, 115, 242
- hypercube, 108
- identity operator, 40
- integer lattice gases, 138
- internal energy, 205
- intersection, 248
- invariants, non-local, 57
- invariants, spurious, 54
- invariants, staggered, 54
- invariants, Zanetti, 54, 57
- irreversible, 22
- Ising model, 37
- isometric collision rules, 113, 115
- isometric group, 57, 113
- isotropic tensors, 90, 104
- isotropy, 10
- Jacobi operator, 220
- Karman vortex street, 70, 85, 123
- Kepler, 108
- Knudsen layer, 80
- Knudsen number, 71, 146, 148, 161
- Korteweg-de Vries equation, 244
- label, 148, 149
- lack of information, 156
- Lagrange multiplier, 68, 134, 156, 250
- Laplacian friction, 220
- Laplacian principle of the insufficient reason, 155
- large eddy simulation, 243
- Latin indices, 49, 57
- lattice gases, 37
- lattice symmetry, 10
- lattice tensors, 40, 90, 91, 128
- lattice tensors, generalized, 95
- lattice vectors, 39, 53
- lattice velocities, 39, 53
- LBGK, 160
- legal rule, 20, 24
- Levy-Civita symbol, 90
- Life, 17, 31, 35
- Liouville equation, 64, 139
- Liouville's theorem, 22
- local configuration, 16
- local Maxwellian, 144
- local rule, 16
- look-up table, 51, 114, 115, 134

- Mach number, 68, 180
- magnetohydrodynamics, 137, 243
- Markov process, 16
- mass fraction parameter, 208
- maximally discretized molecular dynamics, 12
- Maxwell distribution, 141, 143
- Maxwell's equations, 244
- Maxwell-Boltzmann distribution, 141
- memory, see automata rule with memory, 20
- message, 153
- model equations, 144
- molecular chaos, 140
- molecular dynamics, 11
- momentum advection tensor, 72
- Moore neighborhood, 29
- multi-scale analysis, 70, 174
- multi-speed FHP, 101, 205
- multi-speed LGCA, 128
- multi-speed models, 95, 128, 195
- multi-spin coding, 44
- multiphase flows, 137, 243
- Munk scale, 221
  
- Navier-Stokes equation, 7, 74, 145, 152, 174, 177
- neighborhood, Moore, 29
- neighborhood, von Neumann, 29
- node, 39
- nodes: boundary nodes, 189
- nodes: dry, wall nodes, 190
- nodes: wet, interior, fluid nodes, 190
- noise, 163
- nondeterministic rules, 54
- normal distribution, 154
- normalization, 57
- normalized momenta, 114
- numerical distribution functions, 134
- numerical instability, 11
  
- observable, 65
- occupation number, 48
- one-dimensional cellular automata, 18
  
- pair interaction (PI), 118, 129, 130
- Paradise, see Garden of Eden, 22
- partial differential equation, 21
- Pauli principle, 40
- Penrose lattice, 15
- phase space, 64
- PI, 115, 118, 129, 130
- Platonic solids, 105
- Poiseuille flow, 190
  
- Poisson equation, 137
- polyeder theorem, 112
- polygon, 264
- polyhedron, 264
- polytope, 264
- polytope, regular, 264
- porous media, 137, 243
- pressure depends explicitly on velocity, 128, 159
- pressure-corrected LBM, 204
- principle of duality, 249
- propagation, 37, 40, 57
- pseudo-random choice, 54
  
- quantum cellular automata, 36
- quantum mechanics, 138, 244
- quiescent configuration, 20
  
- random generator, 39, 50
- random rule, 115
- Rayleigh-Bénard convection, 244
- Rayleigh-Taylor instability, 244
- reaction-diffusion equations, 138, 242
- reduced densities, 139
- reference system, 90
- relativistic flows, 138
- relaxation toward equilibrium, 50, 69, 83
- Renyi entropy, 158
- rescaling of time, 74
- residue class, 18
- rest mass parameters, 214
- reversible, 22, 37, 121
- Reynolds coefficient, 75, 117
- Reynolds number, 8, 85, 229
- Reynolds number, grid, 227
- Rossby number, 227
- rule number, 19
- rule, local, 16
- rule, see automata rule, 18
  
- Schlaflí symbol, 109, 264
- Schlaflí's criterion, 265
- self-dual, 105
- semi-detailed balance, 58, 67, 87, 113, 115, 138
- Shannon entropy, see: entropy, 22
- sharp distribution, 154
- similarity, law of dynamic, 9
- simplex, 108
- site, 39
- sound speed, 73
- sound waves, 83
- spectral methods, 10

- specular reflection, 80
- spurious invariants, 10, 36, 41, 54, 135
- staggered invariants, 54, 135
- statistical mechanics, 36
- stream function, 220
- streaming, 37, 40, 57
- Stueckelberg condition, 58
- sub-lattice, 40, 118
- supersonic flows, 134
- symmetric rule, 20
- symmetry, 245
- symmetry group, 90, 91, 105
  
- thermal LBM, 205
- thermal LGCA, 128
- totalistic rule, 20, 22–26
- trace, 157
- traffic flow, 36
- transition matrix, 58
- transition probability, 57
- transsonic flows, 134
- turbulence, 145, 183, 243
- Turing machine, 16, 30
  
- union, 248
- universality theorem, 54
- universe as a cellular automata, 17
- update rule, *see* automata rule, 18
  
- von Karman vortex street, 70, 85, 123
- von Neumann neighborhood, 29
- vorticity, 76, 87
- vorticity equation, 183, 220, 230
  
- wave propagation, 244
  
- Zanetti invariants, 54, 57, 135
- Zuse, 17