

Cambridge University Press

978-0-521-84223-5 - Critical Dynamics: A Field Theory Approach to Equilibrium and Non-Equilibrium Scaling Behavior

Uwe C. Täuber

Index

[More information](#)

## Index

- absorbing state, 71, 349, 350, 352, 356, 361, 365, 367, 387, 394, 401, 405, 406, 411, 413, 420, 427, 428, 434–436, 438
- active phase, 73, 350, 352, 394, 401, 402, 412, 415, 427, 433–435, 438, 439
- aging scaling, 311, 444, 455, 457, 462
  - simple, 455, 463
- aging scaling limit, 320, 323, 329, 455
- amplitude ratio, 9, 12, 16, 18, 43
- Anderson localization, 289, 290
- angular momentum, 275
  - generalized, 227, 229–231, 236, 247, 293
- anisotropic random drive, 329, 333
- anisotropic scaling, 135, 226, 329, 332, 402, 403, 422, 448, 449, 457, 458
- anisotropy exponent, 98, 285, 334, 402, 449
- annihilation kinetics, 75, 76, 327, 346, 348, 349, 352, 354, 355, 358, 361, 363–369, 372, 374, 376, 377, 379, 381, 386, 394, 426–430, 432, 433, 435, 438, 488
  - multiple-species, 376, 381, 382, 386, 437
  - two-species, 376–379, 382
- annihilation operator, 253–256, 260, 356, 358–360, 362
- annihilation vertex, 368, 369, 372, 377, 429, 430
- asymmetric exclusion process, 444, 454–456, 468, 473, 478
- autocorrelation exponent, 319, 454–456, 462
- autocorrelation function, 320, 454–456, 461, 462, 493
- autoresponse exponent, 317
- ballistic deposition, 478
- ballistic motion, 81
- barometric height formula, 68
- Belousov–Zhabotinski reaction, 352
- Berezinskii–Kosterlitz–Thouless transition, 174, 300, 476
- Bernoulli’s equation, 274
- Berry phase, 287
- beta function, 186, 191, 192, 201, 214, 222, 233, 244, 246, 298, 371, 408, 419, 430, 434, 435, 450, 459, 482, 484, 485, 489, 494
- Bethe–Salpeter equation, 370, 377
- bicritical point, 432
- binary fluid, 14, 218, 238, 248
- Boltzmann factor, 20, 40, 64, 85, 88, 470
- Bose–Einstein condensation, 266, 268, 269, 271–273, 281, 283
- Bose–Einstein distribution, 259, 279, 301
- boson localization, 284, 289, 290
- boundary conditions, 20, 27, 42, 72, 312, 326, 353, 354, 361, 362, 364, 453, 470
  - antiperiodic, 264, 265, 284
- Dirichlet, 311, 314, 317
- periodic, 27, 67, 256, 259, 277, 284, 291, 444, 466
- reflecting, 68
- branching and annihilating Lévy flight, 435
- branching and annihilating random walk, 427–431, 433–435, 439
  - multiple-species, 433, 438
- branching process, 71, 73, 76, 349, 351, 358, 365, 401, 413, 427–430, 432, 433, 436, 438, 439
- branching vertex, 429, 430
- Brillouin zone, 22, 30, 173
- Brownian motion, 77, 80, 81, 84, 86, 89, 365
- Burgers equation, 452, 453, 469, 473, 476–478, 482, 484, 487, 493, 494
- Cahn–Hilliard equation, 103
- canonical ensemble, 10, 15, 20, 47, 64, 114, 336, 466
- carrying capacity, 352, 359, 412, 413
- causality, 49, 51, 52, 86, 105, 110, 135, 137, 141, 151, 163, 165, 168, 314
- central-limit theorem, 6, 78, 384
- Chapman–Kolmogorov equation, 59, 62, 66, 92
- characteristic frequency, 98, 114, 121, 284, 386
- characteristic function, 338
- characteristic length scale, 135, 274, 286, 319, 320, 324, 327, 353, 378, 391, 475, 476, 485, 489

- characteristic time scale, 73, 78, 97, 99, 101, 106, 113, 115, 119, 135, 209, 216, 234, 235, 238, 284, 313, 319, 346, 348, 402, 427, 436
- Chayes–Chayes–Fisher–Spencer inequality, 489
- chemical equilibrium, 348
- chemical potential, 7, 76, 239, 256, 268, 272, 274, 275, 277, 289
- chemical reaction, 346, 347, 352, 353, 356–359, 361–364, 367–369, 374, 376, 378, 379, 382, 386, 393, 401, 412–414, 421, 425–430, 432, 436 reversible, 346, 382–386, 394
- circularly polarized, 120
- circulation quantization, 275
- classical field equation, 312, 339, 341, 364, 378, 394
- classical limit, 53, 54, 270, 276, 291, 293, 296
- classical mechanics, 40, 157, 339, 361
- classical statistical mechanics, 47, 89, 284
- Clausius–Clapeyron equation, 41
- closed loop, 111, 112, 135, 141–144, 150, 154, 163–165, 168, 169, 266, 274, 322, 326, 430
- closure relation, 255–257, 263, 264, 302, 362
- cluster algorithm, 98
- coarse-graining, 19, 46, 56, 77, 101, 116, 118, 123, 131, 239, 288, 350, 356, 363, 368, 405, 424, 425, 429, 430, 436, 444, 456, 458
- coarsening, 319, 321, 324, 325, 327, 329, 376
- coexistence anomalies, 193, 196, 199, 287, 298, 393
- coexistence curve, 7, 9, 11, 12, 24
- coexistence limit, 197–200
- coexistence phase, 352, 383, 386, 387, 395, 413
- coherence length, 274–276
- coherent state, 252, 254–258, 260–266, 272, 273, 275, 283–285, 302, 352, 355, 362–364, 403, 405
- Cole–Hopf transformation, 366, 446, 474, 479, 487, 488
- combinatorial factor, 112, 145, 150, 164, 335, 370, 430
- commutator, 47, 53, 55, 56, 116–118, 122, 123, 239, 252, 253, 255, 260–262, 288, 356, 360, 362
- composite operator, 137, 198, 220, 221, 231, 242, 243, 281, 295
- compressibility, 7, 9, 19, 92, 273, 290
- condensate density, 272–274, 277
- condensate depletion, 280
- condensate fraction, 267, 269, 271, 282
- condensate wave function, 273, 274
- conditional probability, 58
- conductivity, 100
- connected part, 147–154, 166, 169
- conservation law, 101, 105, 113, 159, 239, 244, 313, 325, 347, 349, 352, 381, 383, 425, 428, 435, 444, 457
- conserved field, 103, 115, 117, 123, 125, 208–211, 216, 217, 229–231, 234, 235, 238, 318, 331, 335, 342, 385, 412, 424, 425
- conserved quantity, 47, 76, 112–114, 117, 122–125, 131, 132, 208, 210, 216, 226, 227, 230, 238, 239,
- 287, 318, 331, 351, 376, 382–385, 425, 437, 445, 457
- contact process, 411, 412
- continuity equation, 66, 83, 91, 92, 102, 113, 239, 274, 445
- continuum limit, 15, 20–22, 31, 40, 59, 68, 70, 101, 256, 258, 264, 267, 268, 270, 276, 280, 288, 291, 294, 346, 352, 353, 355, 362, 363, 367, 368, 376, 383, 387, 394, 401, 403, 405, 414, 423, 428, 436, 444, 446, 457, 490
- contraction, 35, 36, 108, 111, 140–147, 149, 152, 168, 169, 266
- control parameter, 29, 33, 73, 94, 101, 284, 285, 289, 350, 414, 415
- convective term, 240, 453, 477
- corrections to scaling, 17, 34, 193, 312, 313, 341, 381
- correlated region, 26, 277, 285
- correlation function, 6, 11, 14, 16, 23, 31, 33, 41, 109, 112, 136–138, 140, 142, 146, 147, 149, 150, 153, 163, 183, 185, 189, 311, 314, 315, 322–325, 327, 333, 346, 434, 455
- N*-point, 34, 35, 57, 108, 149, 157, 347
- dynamic, 46–48, 52, 57, 65, 87, 92, 99, 104, 106–112, 120, 121, 126, 140, 152, 160, 161, 167, 210, 287, 310, 317, 322–324, 339, 458, 461, 474, 476, 477, 494
- four-point, 34, 35, 110, 126, 146, 148, 149, 153, 169, 266, 281
- Gaussian, 36, 106, 107, 109, 111, 139, 140, 144, 276, 282, 283, 426, 447, 449
- three-point, 281, 458
- transverse, 126, 280
- two-point, 15, 22, 26, 34–36, 43, 110, 126, 139, 145, 150, 162, 216, 299, 311, 320, 409
- two-time, 323
- correlation length, 16, 21, 26–28, 31, 39, 41, 43, 76, 97–99, 105, 121, 156, 192, 276, 284, 285, 287, 289, 299, 327, 350, 402, 438, 485, 489
- correlation propagator, 112, 151–153, 169, 312, 314, 411
- counterterms, 180, 195, 197, 247, 295, 296, 387–389, 395
- creation operator, 252–256, 260, 356, 358–360, 362
- critical decay, 16, 99, 105, 126, 224, 350, 353–355, 367, 368, 371, 372, 374, 378, 379, 381, 385, 394, 402, 411, 412, 416, 427, 436, 454, 456, 493
- critical dimension
- dynamic, 119, 123, 127, 219, 223, 230, 241, 350, 459
- lower, 28, 174, 176, 201, 269, 281, 291, 292, 299, 300, 341, 435, 479, 484, 485, 487, 489
- upper, 23, 32, 38, 172–176, 178, 180, 191, 201, 215, 219, 223, 230, 241, 286, 292, 299, 333, 335, 341, 348, 350, 353, 355, 368, 370, 371, 374, 377, 386, 393, 394, 401, 404, 417, 418, 421–423, 426, 428, 433, 450, 454, 459, 468, 489–492
- critical dispersion, 99

- critical dynamics, 67, 77, 97, 100–103, 112, 113, 115, 118, 122, 124, 125, 127, 136, 152, 159, 160, 208, 218, 219, 226, 228, 235, 237, 238, 240, 291, 310, 318, 319, 329–331, 333, 350, 401, 424, 457, 473, 482
- critical exponents, 14, 23, 24, 27, 28, 32, 43, 98, 177, 182, 185, 189, 191, 194, 195, 204, 216, 267, 269, 271, 285, 291, 300, 310, 311, 317, 318, 330, 335, 402, 412, 416, 417, 439
- directed percolation, 408–412, 417, 427, 428, 431
- directed percolation with conserved field, 426
- driven diffusive systems, 457, 459–461, 463, 468
- Ising, 39, 289
- isotropic percolation, 422, 438
- Kardar–Parisi–Zhang equation, 485, 488
- Lévy directed percolation, 419
- Lévy dynamic percolation, 424, 438
- mean-field, 18, 21, 31, 42, 105, 107, 156, 177, 191, 322, 350, 401, 409, 415, 419, 426, 427, 431, 438, 459–461, 489
- parity-conserving, 435
- roughening transition, 479
- static, 98, 105, 113, 114, 119, 191, 219, 222, 322, 334, 341, 422, 424, 426, 438, 459
- thermodynamic, 25
- critical initial-slip exponent, 310–312, 317, 318, 410, 464
- critical line, 19, 42, 286, 415, 416
- critical opalescence, 9, 16
- critical point, 6–9, 12, 14, 16, 18, 19, 23, 24, 27, 41, 42, 73, 97, 101–104, 106, 107, 113, 126, 172–174, 179, 180, 182, 193, 195, 196, 198, 199, 202, 208, 217, 226, 237, 238, 272, 276, 284–286, 289, 290, 299, 313, 321, 325, 333, 349, 350, 402, 411, 412, 415, 426, 427, 429, 431, 433, 435, 439, 449, 457, 461–463, 474, 485, 487, 488, 491
- critical region, 13, 20, 23, 28, 37, 99, 121, 122, 172, 175, 189, 192, 235, 276, 286, 402, 458
- critical slowing-down, 97, 98, 101, 105, 106, 119, 121, 224
- critical softening, 121
- critical surface, 29, 31, 33
- critical temperature, 6, 11, 20, 39, 269, 270, 283, 290, 298, 457, 461
- critical temperature shift, 38, 102, 175, 177, 179, 180, 194, 221, 341, 406, 418
- Crooks' relation, 336, 338, 465
- crossover, 122, 200, 223, 236, 237, 276, 286, 290, 300, 311, 313, 375, 416, 417, 423, 436, 455, 461, 485
- dimensional, 291, 293, 300, 423
- crossover exponent, 417, 424
- crossover scale, 226, 485, 489
- cubic symmetry, 39, 43
- cumulant, 149–151, 153, 156–158, 162, 165, 166, 180, 210, 220, 230, 231, 242, 279, 281, 316, 457, 465, 466, 493
- four-point, 150, 162, 163, 169
- two-point, 150, 157
- Curie–Weiss theory, 10, 18
- current, 56, 68, 92, 113, 239, 242, 244, 379, 380, 425, 445, 457, 465
- conserved, 241, 243, 245, 246
- longitudinal, 239, 240, 289, 465, 466
- transverse, 239–242, 246
- current correlations, 93, 267, 281, 289, 457, 466, 493
- transverse, 282
- current density, 239, 273
- current fluctuations, 241, 465
- cusp, 22, 270, 271
- dangerously irrelevant, 27, 29, 32, 174, 191, 435, 459
- density correlation function, 48, 267, 278, 386, 454, 455, 458, 461, 463, 493
- density fluctuations, 9, 239, 278, 279, 290, 366, 378, 379, 384, 385, 445, 446, 462
- density matrix, 46, 49, 56
- density of states, 267, 270
- density response, 56, 92
- depletion zone, 349, 352, 367, 373, 376, 377, 381, 386
- detailed balance, 48, 61, 63, 64, 68, 71, 74, 76, 101, 232, 279, 331, 437, 474, 490
- detailed balance violation, 329, 332, 335
- isotropic, 25
- diagrammatic representation, 110–112, 142, 144, 145, 149, 155, 160, 163, 198, 209, 218, 229, 242, 260, 266, 314, 369
- diffusion coefficient
- time-dependent, 83
- diffusion constant, 69, 73, 81, 103, 236, 325, 334, 346, 354, 371, 372, 376, 381, 383, 386, 391, 393, 402, 406, 425, 431, 445, 447, 448, 456, 473
- diffusion length, 353, 378
- diffusion noise, 367, 384
- diffusion-limited, 346, 353, 367, 369, 371–377, 488
- diffusion-limited aggregation, 478
- diffusive mode, 119, 121, 197, 209, 236, 237, 240, 378
- diffusive relaxation, 103, 113, 118, 131, 217, 218, 318, 325, 329, 331, 333, 335, 379, 380, 388, 412, 425, 448, 459, 472–474, 480, 487, 488, 490
- diffusive spreading, 346, 349, 350, 353, 364, 365, 369, 383, 386, 401–403, 412, 417, 421, 424–427, 445
- dimensional regularization, 177, 178, 180, 183, 202, 204, 213, 246, 295, 296, 481, 484
- dipolar interaction, 223, 226, 473
- directed line, 469, 473, 479, 484, 486, 487
- directed percolation, 401–407, 409, 412–417, 420, 421, 423, 425–429, 431, 436
- multiple-species, 412, 414, 416, 436
  - tricritical, 416, 437
- directed percolation conjecture, 406, 411
- Dirichlet correlator, 312, 314, 315, 341
- disclination, 412
- discontinuity, 8, 9, 13, 19, 22, 23, 41, 271, 425, 436, 448
- discretization, 20, 40, 79, 133, 135, 167, 168, 255–259, 264, 288, 294, 362, 366, 488, 490

disorder average, 426  
 disordered phase, 19, 150, 157, 285  
 dispersion, 41, 119, 121, 125, 127, 155, 224, 237, 240, 267–271, 275, 278, 279, 395  
 displacement field, 227  
 dissipated power, 55  
 dissipative dynamics, 103  
 divergence, 6, 8, 9, 12, 16, 18, 22–24, 26, 28, 41, 73, 101, 113, 115, 172, 176, 179, 196, 208, 216, 286, 313, 319, 433, 467, 483–485, 489, 490  
 divergences  
   infrared, 173, 174, 177, 178, 281, 287, 314, 467, 483  
   ultraviolet, 141, 172–178, 180–182, 184, 185, 203, 204, 214, 222, 232, 295, 314, 316, 334, 342, 407, 422, 480  
 Doi–Peliti action, 362–364, 367, 372, 376, 377, 383, 386, 387, 394, 401, 403, 412, 413, 421, 428–430, 432, 436, 439, 446  
 domain wall, 20, 28, 42, 75, 97, 289, 320, 325, 326, 328, 426, 469, 472  
 domain wall density, 76, 77, 97  
 drift velocity, 69, 471  
 drift-diffusion, 66, 69, 70, 82, 446, 447  
 driven diffusive systems, 67, 444, 446, 448, 449, 453–459, 464, 466, 473, 480, 481, 484, 492  
   critical, 456–460, 462, 464, 468, 493  
 driven interface, 469, 472  
 driven lattice gas, 444, 456  
   Ising, 333, 456, 474  
 dynamic critical exponent, 98, 100, 113, 135, 156, 208, 217, 242, 284, 285, 297, 311, 318, 322, 325, 335, 342, 402  
 Bose–Einstein condensation, 271  
 boson localization, 290  
 directed percolation, 409  
 driven diffusive systems, 463  
 dynamic isotropic percolation, 422, 423, 438  
 effective, 98  
   Kardar–Parisi–Zhang equation, 488  
 Lévy directed percolation, 419  
 Lévy dynamic percolation, 424, 438  
 mean-field, 105, 119, 120, 124, 215, 234, 238, 246, 350  
 model A, 105, 190, 192, 217  
 model B, 105, 181, 190, 217, 224  
 model C, 115, 216, 217  
 model D, 115, 216, 217  
 model E, 124, 126  
 model G, 127, 237, 238  
 model H, 244, 246  
 model J, 119, 121, 222, 223, 226  
 parity-conserving, 435  
 SSS model, 228, 233  
   transverse quantum Ising chain, 289  
 dynamic scaling, 101, 190, 225, 226, 237, 468  
   strong, 124, 127, 216, 217, 228, 233–236, 238  
   weak, 124, 216, 217, 233–236, 238

dynamic scaling exponent, 217, 235, 325, 329, 455, 476  
 coexistence limit, 198  
 driven diffusive systems, 449, 453, 477  
   Kardar–Parisi–Zhang equation, 477, 483, 489  
   long-range KPZ equation, 494  
 dynamic scaling hypothesis, 97, 99, 100, 107, 113, 115, 121, 126, 319, 325, 327  
 Dyson’s equation, 36, 154–156, 369, 370, 372, 374  
 easy-axis ferromagnet, 122  
 easy-plane ferromagnet, 122  
 Edwards–Wilkinson equation, 469, 474–476, 491  
 effective action, 197, 291, 293, 295, 401, 404, 414, 425, 430, 437  
 effective coupling, 29, 30, 119, 123, 172, 174, 202, 222, 232, 241, 242, 244, 294, 370, 404, 408, 419, 433, 450, 459, 494  
 effective field, 10  
 effective Hamiltonian, 19, 42, 64, 91, 116, 122, 174, 227, 276, 280, 281, 288, 292, 333, 421, 472  
 effective temperature, 91  
 Ehrenfest’s correspondence principle, 116  
 Einstein relation, 80, 81, 83, 84, 87, 89, 91, 93, 102, 103, 131, 136, 208, 210, 329–331, 334, 356, 445, 452, 453, 470, 472  
 electrodeposition, 478, 479  
 energy correlation function, 114  
 energy density, 113–115, 208–210, 216, 217, 230, 239, 247, 331  
 energy dissipation, 80, 326, 327  
 energy fluctuations, 114, 208, 331, 335  
 entanglement correlations, 252, 269  
 entropy, 8, 11, 126, 239, 270, 271  
   time-dependent, 60  
 entropy current, 126  
 entropy flux, 61  
 entropy production, 61  
 epidemic process  
   general, 412, 420  
   simple, 401, 405, 419, 437  
 equation of state, 6, 8, 11, 14, 15, 18, 20, 24, 194, 268, 271  
   caloric, 9, 41  
 equilibrium condition, 91, 116, 127, 131, 331, 335, 453, 470, 472  
 equilibrium statistical mechanics, 6, 10, 28, 68, 131, 132, 141, 166, 466, 469, 473, 486  
 equipartition theorem, 80, 87, 93  
 ergodicity, 319  
 Euler’s equation, 274  
 exciton recombination, 374  
 exclusion, 359, 386, 444–446, 455–458  
 extinction probability, 73  
 extinction threshold, 73, 93, 97, 352, 401, 402, 405, 406, 413, 420  
 extinction time, 361

- Fermi's golden rule, 54, 64  
 Fermi–Dirac distribution, 266, 301  
 ferrofluid, 411  
 ferromagnetic, 9–11, 13, 14, 74, 117, 121, 122, 224, 287, 289, 292, 388  
 Feynman diagram, 110–112, 135, 142, 143, 145–154, 156, 158, 161, 163–166, 168, 169, 175, 194, 198, 199, 211–213, 219, 221, 231, 232, 244, 247, 248, 260, 266, 296, 314, 315, 322, 368, 370, 372, 374, 377, 389, 390, 393, 406, 407, 418, 422, 429, 431, 439, 448–450, 460  
 Feynman parametrization, 203  
 Feynman rules, 110, 149–151, 153, 163, 165, 406  
 Fick's diffusion law, 70, 81  
 field fluctuations, 94, 111, 133, 227, 277, 330, 331, 387, 413  
 field renormalization, 183, 184, 198, 210, 219, 314, 316, 380, 391, 407, 408, 423, 447, 448, 481, 482  
 field theory, 101, 131, 135, 140, 141, 151, 172, 177, 179, 182, 187, 217, 218, 276, 284, 285, 299, 310, 352, 355, 359, 363, 364, 367–369, 382, 386, 401, 403, 411–413, 421, 423, 428, 432, 436, 439, 447, 457, 479, 480, 485, 488, 490  
 massless, 178, 200  
 renormalizable, 176  
 field theory representation, 112, 131–133, 135, 228, 355, 367  
 finite-size scaling, 27, 237, 238, 284, 286, 453, 454, 461, 463, 464, 478  
 Fisher exponent, 26, 119, 156, 181, 299  
 Fisher–Kolmogorov equation, 351, 394, 401, 405  
 fission process, 346, 348  
 fixed line, 235, 300  
 fixed point, 29, 31, 33, 38, 39, 43, 114, 119, 123, 182, 185, 189, 191, 201, 215, 233, 234, 244, 298, 300, 318, 322, 331, 332, 334, 335, 460, 476, 482  
 annihilation, 371, 373, 381, 395, 428–430, 432, 434, 439  
 coexistence, 193, 201, 298  
 conserved KPZ, 492, 494  
 critical, 31, 32, 216, 298, 434, 435, 476, 479, 483, 485, 488  
 critical driven diffusive systems, 460, 468  
 directed percolation, 409, 411  
 driven diffusive systems, 450, 452, 467  
 Edwards–Wilkinson, 482, 485, 490  
 equilibrium, 331, 452, 453  
 Gaussian, 38, 191, 192, 201, 215, 222, 298, 371, 409, 419, 434, 475, 476, 485, 490  
 Heisenberg, 191, 192, 215, 317, 330  
 infrared-stable, 33, 185, 189, 190, 201, 215, 216, 222, 234, 236, 246, 316, 330, 371, 372, 409, 419, 423, 438, 450, 452, 460, 467, 468, 475, 479, 483, 485, 492, 494  
 Ising, 38  
 Kardar–Parisi–Zhang, 482–484, 494  
 Lévy directed percolation, 419  
 long-range KPZ, 494  
 model A, 234  
 model C/D, 215, 216  
 model H, 246  
 model J, 222  
 non-equilibrium, 331  
 parity-conserving, 434, 435  
 quantum critical, 300  
 SSS model, 234–236, 238  
 strong-coupling, 489  
 strong-disorder, 426  
 ultraviolet-stable, 298, 300, 485  
 zero-temperature, 193, 287, 321, 325  
 flame front propagation, 473, 478  
 fluctuation correction, 23, 32, 36, 37, 105, 154, 155, 172, 175, 184, 191, 209, 211, 219, 223, 277, 300, 314, 355, 361, 364, 369, 370, 373, 382, 386, 387, 390, 391, 393–395, 418, 422, 429, 431, 433, 436, 438, 448, 450, 483, 491, 492  
 fluctuation-dissipation ratio, 313, 341  
 fluctuation-dissipation theorem, 46, 52, 53, 55, 65, 80, 87, 99, 107, 120, 135, 137, 138, 161, 162, 169, 181, 187, 210, 311, 313, 334, 336, 339, 342, 356, 453, 477, 481, 484  
 fluctuation-response theorem, 15, 26, 54  
 fluctuations, 6, 10, 14, 19, 21, 23, 28, 30, 37, 38, 71, 94, 101, 172, 177, 179, 197, 231, 247, 275, 276, 282, 285, 286, 292, 293, 295, 302, 310–312, 323, 331, 332, 334, 336, 339, 340, 346, 348, 350, 352, 355, 378, 381, 383–386, 389, 393, 401, 405, 409, 414, 425, 427, 429, 431, 432, 434, 435, 437, 450, 465, 475, 487, 491  
 Fock space, 252–255, 261, 262, 273, 356, 357, 362, 446  
 Fokker–Planck equation, 65, 66, 69, 82, 85, 86, 89, 91, 92, 94, 381  
 forward discretization, 59, 90, 132, 135, 141, 168  
 fractal, 26  
 free energy, 11, 13, 17–19, 22, 23, 26, 28, 31, 33, 37, 40, 42, 102, 132, 168, 196, 287, 338, 340, 341, 470, 487  
 dynamical, 465–467  
 singular part, 24, 33, 284, 285, 290  
 free energy density, 14, 17–19, 24, 33, 42, 174, 285, 290  
 free enthalpy, 7  
 friction, 78, 92  
 fugacity, 267, 271, 276  
 functional derivative, 20, 34, 35, 39, 109, 137, 138, 149, 157–159, 162, 196, 227, 240, 244, 325, 339, 493  
 functional determinant, 132, 141, 167, 168, 277, 488  
 functional integration, 20, 40, 79, 133, 134, 256, 257, 260, 264, 294, 337, 362, 365, 366, 466, 486, 488  
 functional measure, 20, 21, 79, 85, 132–134, 167, 256, 257, 264, 277, 294, 337  
 fusion process, 76, 346, 358, 364, 366, 367, 372, 374, 395, 401, 402, 404, 412, 430, 436

- Galilean invariance, 238, 240, 243, 248, 444, 447, 450, 453, 457, 459, 476, 477, 482, 484, 485, 487, 492  
 Galilean transformation, 69, 240, 248, 447, 450, 453, 459, 477, 480, 493  
 gauge invariance, 273, 276, 281, 290  
 Gaussian ensemble, 34, 35, 106, 108, 110, 126, 139, 266, 281, 302, 310  
 Gaussian integral, 22, 37, 40, 114, 132, 134, 139, 168, 258, 262, 265, 340, 385, 467  
 Gaussian model, 21, 23, 29–31, 41, 43, 101, 103–107, 109, 110, 113, 119, 120, 123, 126, 138–140, 161, 166–168, 195, 197, 209, 239, 241, 267, 275, 277–280, 282, 312, 313, 333, 339–341, 368, 388, 447, 448, 458, 459, 461, 466, 468, 474, 477  
 generating function, 14, 71, 93, 360, 457, 465, 493  
 generating functional, 34, 35, 138, 149, 157, 196, 243, 312, 318, 341, 493  
 generator, 122, 219, 226, 228, 230, 239  
 generic scale invariance, 384, 386, 434, 437, 444, 447, 469, 474  
 geometric factor, 37, 179, 219, 232, 429, 481  
 Gibbs–Duhem relation, 7, 267  
 Ginzburg–Levanyuk criterion, 23  
 glassy phase, 309, 487  
 Glauber kinetics, 74, 76, 77, 97–99, 101, 102, 320, 426, 432  
 Goldstone mode, 121, 131, 193, 196, 197, 199, 202, 237, 287, 292, 393  
 Goldstone’s theorem, 196  
 grand-canonical ensemble, 7, 268  
 grand-canonical partition function, 256, 257, 259, 263, 264, 266, 267, 272, 277  
 grand-canonical potential, 239, 267, 269, 272  
 Grassmann variable, 261–264, 266, 284, 302  
 Green function, 70, 80, 84, 132, 258, 259, 265, 275, 276, 279, 280, 302, 321, 340, 378, 384  
 Gross–Pitaevskii equation, 266, 272, 274, 275, 283  
 growth law, 327–329, 462, 464  
 Hamilton’s equations, 361  
 Hartree loop, 112, 144, 166, 232, 315, 322  
 height fluctuations, 469, 471, 473, 475, 477, 490  
 Heisenberg antiferromagnet, 127, 237, 238, 291, 292, 300  
 Heisenberg ferromagnet, 119, 121, 199, 200  
 Heisenberg model, 28, 42, 117, 119, 122, 127, 135, 136, 153, 202, 226, 237, 277, 292  
 Heisenberg picture, 47, 56, 258  
 Heisenberg’s equation of motion, 47, 55, 116  
 helium 4, 24, 25, 126, 235–237, 271, 283  
 hierarchy level, 415, 416, 424  
 hierarchy rule, 57  
 high-temperature phase, 16, 19, 21, 24, 26, 31, 34, 43, 103, 104, 108, 139, 157, 162, 167, 195, 204, 220, 319, 320, 457, 458, 462  
 homogeneous function, 23, 100  
 hopping transport, 67, 358, 363, 374, 394, 401, 417, 444, 446, 454, 457  
 Hubbard–Stratonovich transformation, 133, 321  
 hydrodynamic description, 113, 121, 274, 452, 469, 477  
 hydrodynamic mode, 101, 112, 115, 116, 239, 246, 287  
 hydrodynamic region, 121, 122  
 hyperscaling relation, 26, 33, 216, 285, 402, 435, 487  
 ideal gas, 6  
 imaginary time, 62, 87, 256, 264, 272, 276–278, 280, 281, 284, 285, 287–289, 291, 357, 362, 486  
 inactive phase, 73, 349, 412, 415, 427, 429, 434, 436  
 infrared cutoff, 275, 328, 355  
 initial conditions, 70, 84, 86, 310–312, 314, 341, 352, 359, 360, 362, 364, 372, 377–379, 381, 383–385, 411, 427, 455, 474, 475, 484, 487  
 correlated, 455, 463, 464  
 random, 310, 313, 318, 319, 323, 379, 382, 383, 385, 462  
 sharp, 312  
 initial-slip scaling, 317, 341, 455, 456, 462, 464, 493  
 interaction representation, 52  
 interface fluctuations, 469, 473, 475–477, 479, 490  
 interfacial tension, 28, 471, 472  
 intermittency, 411  
 invasion front, 350, 394  
 inversion symmetry, 16, 19, 446  
 irrelevant, 29, 32, 33, 104, 124, 174, 177, 192, 209, 215, 222, 228, 241, 276, 284, 332, 393, 404, 406, 417, 421, 432, 433, 436–438, 468, 475, 490, 493  
 irreversible, 131, 348, 358, 423  
 irrotational flow, 273  
 Ising ferromagnet, 98, 101, 333, 469  
 Ising lattice gas, 14, 76, 445, 456, 457, 461, 464, 474, 478, 493  
 Ising model, 9, 12, 13, 15, 18, 28, 29, 38, 41, 76, 122, 135, 202, 239, 284, 287–289, 320, 457, 469, 472  
 kinetic, 74, 75, 97, 101, 426, 432  
 Ising symmetry, 10, 11, 17, 20, 28, 32, 101, 102, 113, 136, 216, 325, 432, 446  
 isotherm, 6, 7  
 critical, 9, 12, 18, 24  
 isotropic antiferromagnet, 126, 127, 218, 226, 228, 236, 237, 293  
 isotropic ferromagnet, 113, 117, 118, 124, 126, 217–219, 223, 226, 318, 330  
 isotropic percolation, 402, 403, 412, 422, 423  
 dynamic, 422, 423, 438  
 dynamic multiple-species, 424, 436  
 Lévy dynamic, 424  
 Itô representation, 132, 135, 168  
 itinerant ferromagnet, 225, 226  
 Jacobian, 132, 133, 135, 167, 168, 294, 296, 366  
 Janssen–De Dominicis functional, 133, 134, 167, 195, 209, 241, 260, 337, 364, 377, 383, 387, 404, 421, 424, 438, 444, 447, 458, 466, 488, 491  
 Jarzynski’s non-equilibrium work, 337–339, 342

## Index

## 505

- Jarzynski's work theorem, 336, 338, 339  
 joint probability, 57, 88  
 Josephson scaling, 290
- Kardar–Parisi–Zhang equation, 456, 469, 471–480,  
 484, 485, 487–490, 492, 493  
 conserved, 479, 490–492, 494  
 long-range noise, 494
- Katz–Lebowitz–Spohn model, 456–458, 461, 463,  
 464, 493
- Kawasaki dynamics, 76, 102, 426, 457  
 kinetic roughening, 478, 491  
 Kolmogorov criterion, 61, 68  
 Kramers–Kronig relation, 51, 52, 54  
 Kramers–Moyal coefficient, 66, 69, 81, 85, 91  
 Kramers–Moyal expansion, 65, 66, 70, 81  
 Kubo relaxation function, 50, 92, 223, 247  
 Kuramoto–Sivashinski equation, 473
- Lévy flight, 374, 394, 412, 417–419, 424, 435, 438  
 Lagrangian, 256, 260, 264  
 Landau expansion, 17, 19, 24, 32, 42, 272, 277  
 Landau–Ginzburg theory, 16, 20, 23, 40, 42, 266, 272,  
 275, 287, 326, 339, 341, 470
- Landau–Ginzburg–Wilson Hamiltonian, 17, 20, 28,  
 29, 32, 34, 42, 101, 104, 113, 118, 135, 217, 219,  
 227, 231, 276, 288, 289, 292, 298, 321, 336, 469
- Landau–Placzek mode, 240
- Langevin equation, 77, 78, 80, 81, 83, 88–90, 93, 94,  
 101, 102, 104, 108, 112, 114–116, 123, 124,  
 131–135, 145, 153, 166–168, 172, 208–210, 218,  
 227, 228, 239, 240, 247, 248, 331, 333, 339, 342,  
 356, 364, 365, 367, 377, 383, 384, 387, 389, 394,  
 401, 404, 406, 413, 414, 420, 424, 432, 445, 447,  
 453, 456–458, 467, 468, 471, 472, 475, 479, 490  
 linearized, 104, 119, 120, 124, 127, 240, 474  
 overdamped, 85, 86, 101
- large-deviation function, 457, 464, 465  
 lasing threshold, 94  
 latent heat, 8, 41  
 law of corresponding states, 8  
 law of mass action, 346, 348  
 Legendre transformation, 14, 156, 157, 465  
 line tension, 275, 486, 487  
 line width, 79, 107, 221, 223–226, 237, 247, 494  
 linear response, 46, 49, 50, 52, 56, 92, 102  
 linked cluster theorem, 141  
 Liouville equation, 56, 89  
 Liouville operator, 62, 63, 357  
 liquid crystal, 412, 473, 479  
 localization, 289  
 logarithmic corrections, 39, 173, 177, 192, 204, 327,  
 329, 341, 355, 368, 372, 374, 377, 379, 381,  
 393–395, 436, 454, 456, 469, 475, 492
- long-range correlations, 333, 335, 475, 489, 494  
 long-wavelength expansion, 15, 19, 31, 102, 104, 174,  
 437, 446, 471, 473, 475, 490  
 longitudinal fluctuations, 197–199, 236, 294, 332, 333
- loop expansion, 112, 149, 154, 167, 406, 450, 480, 483  
 Lorentzian approximation, 223, 234, 244, 247, 494  
 Lorentzian curve, 79, 107, 224  
 Lotka–Volterra model, 351, 352, 358, 383, 386, 395,  
 412  
 low-temperature expansion, 291, 295  
 low-temperature phase, 16–18, 20, 23, 24, 26, 31, 43,  
 104, 193, 196, 199, 202, 280, 292, 341, 487  
 LRC circuit, 87, 93
- macroscopic ring exchange, 277, 289  
 magnetic flux line, 486  
 magnetization, 10, 11, 76, 117, 219, 292, 319, 445,  
 457, 469  
 conserved, 102, 117, 122, 126, 127, 226  
 magnetization current, 102  
 magnetization density, 101, 117, 127, 138, 218  
 magnetization fluctuations, 13, 119, 124, 127, 226  
 magnetization relaxation, 98  
 magnon, 121, 237  
 marginal, 22, 29, 32, 33, 174, 177, 209, 328, 368, 487  
 Martin–Siggia–Rose auxiliary field, 133, 163, 166,  
 168, 193, 220, 260, 337, 365, 421, 432  
 mass density, 239, 282  
 master curve, 24, 100  
 master equation, 60–62, 65, 68, 71, 92, 93, 346, 347,  
 352, 355–359, 361–364, 367, 369, 394, 403, 405,  
 436, 446  
 matrix form, 62  
 matching condition, 33, 190, 192, 201, 204, 316, 317,  
 409, 410, 435, 467, 468  
 Matsubara frequency, 259, 265, 278, 280, 295, 301,  
 302  
 Maxwell's construction, 7  
 Maxwell–Boltzmann distribution, 83, 84  
 mean-field theory, 6, 10–16, 18–20, 23, 25, 75, 77, 98,  
 101, 103–105, 115, 119, 172, 192, 193, 198, 199,  
 201, 202, 273, 292, 334, 346–354, 356, 364, 368,  
 372–374, 377–379, 381–383, 386, 387, 393–395,  
 413, 415, 416, 425, 427, 429, 431, 434, 436, 437,  
 449, 458, 491  
 measurement time, 313  
 memory, 58, 78, 90, 412, 420–423  
 Mermin–Wagner–Hohenberg theorem, 28, 199, 201,  
 298  
 mesoscopic description, 46, 57, 77, 101, 116, 117,  
 350, 356, 367, 401, 405, 420, 437, 447  
 method of characteristics, 72, 188, 372, 409  
 Metropolis algorithm, 65  
 micro-canonical ensemble, 64, 466  
 micro-reversibility, 64  
 minimal subtraction, 180, 183, 204, 212, 213, 222,  
 233, 246, 334, 452, 467, 481  
 mode coupling, 112, 113, 115, 118, 119, 124–127,  
 131, 137, 138, 168, 217, 220, 222, 223, 226, 229,  
 233, 235, 238, 243, 244, 246, 293, 318, 329, 330,  
 335, 339, 342  
 mode-coupling equation, 223, 226, 247, 248, 494

- mode-coupling theory, 113, 223, 226, 234, 244, 247, 293, 393, 484, 490  
 mode-coupling vertex, 218, 219, 222, 229, 230, 242, 243, 330  
 model A, 102, 104–106, 124–126, 135, 137, 150, 161, 166, 172, 175–177, 179, 183–185, 187, 190, 192, 193, 196, 197, 199, 204, 208, 209, 217, 228, 230, 232, 235, 238, 246, 310, 311, 313, 315–319, 321–324, 328–331, 335, 336, 341, 368, 404, 406, 410, 432, 455, 470–472, 474, 482, 490  
 model B, 103–106, 119–122, 126, 135, 137, 150, 159–162, 166, 172, 175–177, 179, 181, 183, 187, 190, 204, 209, 210, 217–220, 238, 241, 246, 310, 311, 313, 315–318, 321–325, 329–332, 334–336, 341, 455, 457–459, 490, 492  
 driven, 457–460, 468  
 two-temperature, 329, 333–335, 342, 449, 457–459, 464  
 model C, 113, 114, 208–216, 229, 246, 318, 319, 329–332, 335, 424  
 model D, 113, 114, 208–210, 212, 213, 215, 217, 219, 230, 238, 246, 329–331, 335  
 two-temperature, 335  
 model E, 113, 124, 125, 127, 218, 228, 236, 329, 330  
 model F, 236  
 model G, 126, 127, 218, 228, 236, 293, 329, 330  
 model H, 218, 238, 241, 242, 244, 247, 248, 329–331, 335  
 two-temperature, 335  
 model I, 113, 118, 119, 121, 125, 217–221, 226, 229, 231, 247, 318, 329, 330, 335  
 two-temperature, 335  
 molecular beam epitaxy, 491  
 momentum density, 239  
 Monge gauge, 469, 471  
 monopole, 326  
 Monte Carlo simulation, 65, 98, 237, 320, 381, 382, 386, 393, 403, 410–412, 428, 433, 435, 454–456, 461–464, 489  
 path integral, 283  
 Mori-Zwanzig projector formalism, 116, 223  
 Mott transition, 290  
 multi-critical point, 412, 414, 416, 424, 436  
 Néel temperature, 237  
 nematic order, 412, 479  
 neutron scattering, 224–226, 237, 289  
 Newton's equation, 78, 84  
 noise, 77, 102, 103, 134, 325, 365, 383, 389, 405, 445, 448, 468, 469, 473, 474, 477, 484, 487, 494  
 anisotropic, 329, 332, 335, 342  
 conserved, 103, 114, 209, 446, 452, 458, 491  
 Gaussian, 90, 103, 111, 260, 365, 387, 413, 432, 466, 473  
 multiplicative, 260, 356, 365, 377, 387, 404–406, 413, 422, 432, 473, 487, 488  
 thermal, 85, 323  
 white, 79, 83, 90, 131, 365, 387, 413, 432, 466, 472  
 noise correlation, 78, 80, 90, 91, 114, 118, 123, 132, 134, 218, 227, 240, 260, 325, 330–333, 335, 337, 356, 365, 366, 377, 383, 384, 387, 405, 406, 413, 414, 420, 425, 432, 447, 453, 467, 470, 472–474, 477, 489, 490, 494  
 noise functional, 406, 437  
 noise histories, 79, 90, 133, 311, 365, 465  
 noise operator, 131, 133  
 noise strength, 80, 91, 111, 131, 150, 164, 165, 232, 330–332, 334, 445, 449, 468, 472, 473, 493  
 noise vertex, 111, 112, 142, 144, 150–152, 160, 164, 169, 182, 184, 209–211, 219, 221, 233, 246, 247, 314, 404, 406, 407, 422, 447, 448, 460, 480, 491  
 non-equilibrium perturbation, 331, 332  
 non-equilibrium processes, 46, 67, 68, 71, 132, 153, 336, 337, 339, 342, 357, 367, 384, 406, 411, 426, 437, 444, 455, 458, 466, 469, 472, 474, 479  
 non-equilibrium regime, 56, 64, 77, 311, 336, 356, 426, 444, 461, 469, 470, 473, 478, 490  
 non-equilibrium stationary state, 56, 68, 91, 455, 461, 462, 465  
 non-equilibrium statistical mechanics, 56  
 non-linear sigma model, 174, 291, 292, 294–298, 300, 302, 423, 435, 479, 484, 485  
 normalfluid density, 267, 282, 283  
 normalization point, 182–185, 200, 211, 222, 232, 297, 316, 371, 408, 418, 429, 433, 451, 460, 467, 480, 481, 489  
 numerical simulations, 27, 65, 98, 320, 329, 410, 412, 435, 437, 453, 461, 463, 478, 484, 489, 490  
 Nyquist's theorem, 93  
 occupation number representation, 252, 356, 357, 359  
 off-diagonal long-range order, 277, 281  
 one-particle irreducible, 154, 156, 158, 160, 162, 163, 166, 169, 220  
 one-vertex irreducible, 199  
 Onsager coefficient, 91, 105, 132, 225, 342, 472  
 Onsager–Machlup functional, 132–134, 137, 167  
 operator product expansion, 317  
 order parameter, 6, 9, 11, 17, 19, 24, 73, 99, 101, 114, 115, 123, 126, 136, 183, 193, 194, 196, 198, 201, 204, 208, 210, 211, 216, 217, 227, 230, 232, 234, 236, 239, 240, 245–247, 269, 272, 285, 292, 299, 311, 318, 319, 324–327, 331, 332, 335, 341, 393, 402, 410–412, 417, 424, 426, 461, 462, 464, 485  
 anisotropic, 462  
 complex, 273, 274  
 conserved, 103, 106, 111, 112, 114, 118, 122, 159, 161, 176, 181, 184, 187, 191, 208, 209, 212, 215, 217, 218, 238, 241, 246, 311, 315, 317, 318, 320, 321, 323, 324, 328, 329, 331, 334–336, 342, 455, 457, 480, 490, 492  
 homogeneous, 20, 102, 117, 174, 193, 202, 272, 277

*Index*

507

- non-conserved, 98, 102, 105, 106, 112, 114, 124, 126, 185, 187, 191–193, 197, 208, 209, 215, 216, 226, 311, 313, 317, 318, 320, 321, 323, 324, 328, 331, 332, 335, 336, 424, 470, 472, 474, 490  
 scalar, 14, 101, 114, 215, 216, 238, 242, 246, 406, 424, 445, 457, 458, 469  
 spontaneous, 18, 99, 120, 195  
 vector, 42, 115, 118, 123, 135, 208, 209, 291, 325, 326
- order parameter components, 23, 39, 43, 115, 127, 136, 139, 151, 202, 208, 215, 218, 226, 228, 230, 321, 324, 325, 327
- order parameter density, 19, 102, 209, 216
- order parameter discontinuity, 19, 42
- order parameter dynamics, 97, 101, 114, 176, 181, 187, 191, 208, 217, 235, 238, 246, 315, 331
- order parameter field, 19, 36, 42, 103, 108, 110, 111, 113, 126, 174, 210, 218, 230, 231, 234, 236, 241, 242, 274, 275, 287, 293, 297, 300, 310, 321, 326, 330, 336, 406, 424, 436, 457, 470
- order parameter fluctuations, 18, 19, 102, 127, 131, 208, 216, 232, 235, 238, 242, 290, 321, 331, 332, 461
- ordered phase, 19, 26, 27, 104, 108, 113, 120, 124, 126, 127, 169, 193, 195, 196, 200, 202, 236, 285, 291, 292, 294, 298, 319, 320, 323, 325, 327, 329
- Ornstein–Uhlenbeck process, 90
- Ornstein–Zernicke correlation function, 14, 16, 108, 109, 276
- Ostwald ripening, 320
- overdamped, 121, 224, 237, 240
- pair contact process with diffusion, 436
- pair production, 365
- paramagnetic, 10, 11, 13, 119, 121, 287, 289, 297
- paramagnon, 119, 121, 225
- parity-conserving, 427, 428, 432, 434, 435
- particle anticorrelations, 346, 349, 353, 366, 368, 376, 377
- particle number fluctuations, 7, 9, 73, 93, 273, 301
- particle segregation, 349, 376, 378, 379, 381, 382, 386
- partition function, 10, 11, 14, 20, 21, 29–31, 34, 40, 41, 64, 89, 132, 141, 287, 288, 291, 294, 321, 322, 340, 486
- dynamical, 465, 468
- path integral representation, 252, 255, 257, 260, 264, 272, 283–285, 302, 352, 355, 362–364, 366, 403, 405, 486
- pattern formation, 352
- Pauli’s exclusion principle, 260
- Pawula’s theorem, 66, 82
- percolation threshold, 401, 403, 406, 409, 410, 418, 426, 431
- permutation operator, 252
- persistence, 318
- persistence exponent, 317, 319
- perturbation expansion, 34, 35, 38, 101, 103, 104, 108, 110, 112, 131, 133, 135, 140, 142, 149–156,
- 159, 160, 166, 167, 172–174, 176, 180, 191, 195, 208, 209, 218, 241, 260, 265, 283, 295, 314, 322, 372, 374, 393, 401, 404, 406, 409, 422, 431, 433, 450, 480, 484, 488  
 all orders, 155, 159, 161, 176, 181, 200, 204, 210, 219, 231, 243, 316, 334, 368, 371, 417, 418, 423, 426, 439, 448, 455, 459, 460, 468, 479, 480, 485, 486, 488, 489
- perturbation theory, 23, 28, 104, 109, 135, 149, 152, 165, 172, 176, 189, 194, 223, 230, 236, 367, 417, 418, 422, 425, 429, 431, 433, 447, 476, 479, 483, 489, 490, 492, 494  
 dynamic, 101, 103, 104, 142, 151, 166, 210, 222  
 fixed dimension, 433  
 time-dependent, 52, 55
- perturbation theory elements, 110–112, 142, 150, 151, 210, 218, 260, 295, 480
- phase coexistence, 8, 12
- phase coherence, 277, 285, 289
- phase correlation function, 278
- phase diagram, 6, 8, 12, 173, 199, 286, 352, 415, 416, 424, 435, 438
- phase field, 273
- phase fluctuations, 94, 278, 279, 282, 289
- phase ordering, 319, 325
- phase separation, 7, 9, 14, 218, 320, 329, 457
- phase transition, 9, 14, 16, 17, 24, 29, 31, 43, 114, 115, 124, 191, 209, 217, 270, 271, 284, 285, 290, 331, 350, 407, 431, 432, 457, 459, 473, 485, 489
- active to absorbing, 401, 402, 405, 406, 411, 412, 414, 415, 424–427, 429, 431, 433, 436–438
- antiferromagnetic, 127
- boundary-induced, 445
- continuous, 19, 24, 26, 38, 73, 101, 106, 174, 269, 276, 284, 286, 289, 310, 350, 352, 355, 406, 416, 425, 431, 434, 436, 438, 456, 483
- ferromagnetic, 6, 14
- first-order, 8, 11, 19, 42, 104, 425
- gas–liquid, 6, 8, 14, 16, 218, 238, 239
- non-equilibrium, 350, 427, 436, 437, 456, 457, 469, 476, 483, 489, 491
- normal- to superconducting, 100
- normal- to superfluid, 24, 25, 236, 267, 276, 277, 283, 289, 290
- second-order, 8, 16–19, 23, 28, 42, 97, 101, 112, 113, 135, 286, 292, 329, 457, 476, 487
- structural, 227, 333
- phonon, 333
- acoustic, 278
- phonon approximation, 281, 283
- planar ferromagnet, 113, 124, 125, 127, 218, 226, 228, 235, 473
- Poisson bracket, 47, 56, 116, 118, 123, 127, 227, 228, 239
- population dynamics, 70, 74, 93, 97, 346, 350, 352, 386, 393, 401, 412, 413
- population explosion, 351
- population oscillation, 351, 383, 386, 388, 393

- Porod's law, 327, 328  
 potential function, 6, 64, 101, 470, 477, 486, 487  
 precession, 118, 218, 224, 226  
 predation, 351, 352, 386, 413  
 predator-prey competition, 351, 383, 386, 387, 395  
 predator-prey competition, 358, 412, 413  
 pressure fluctuations, 240  
 primitive degree of divergence, 172, 175, 176, 204  
 probability amplitude, 258  
 probability conservation, 56, 62, 360, 361, 364, 369  
 probability current, 56, 64, 66, 83, 85, 91, 116, 331, 335  
 probability distribution, 20, 56–59, 65, 66, 82, 88, 131, 132, 134, 167, 302, 338, 347, 356, 357, 379, 417, 465  
 canonical, 55, 64, 74, 85, 89, 91, 102, 116, 330, 336, 453, 474  
 Gaussian, 70, 79, 82, 85, 132, 167, 379, 384, 465, 477, 486  
 Poissonian, 254, 273, 359, 360, 362, 378  
 stationary, 61, 63, 64, 68, 83, 84, 89, 91, 94, 474, 477  
 uniform, 64, 68  
 projection state, 62, 360, 362  
 projector, 239  
 longitudinal, 226  
 transverse, 240, 242, 282  
 propagating mode, 121, 126, 224, 237, 239, 240, 388, 389, 393  
 propagator, 35, 37, 108, 110–112, 142, 144–146, 149–152, 154, 156, 159, 160, 162, 164, 165, 167, 169, 209, 210, 220, 229, 241, 255, 257, 259, 260, 264, 265, 296, 302, 312, 314, 322, 335, 341, 364, 368, 374, 378, 388, 390, 395, 406, 417, 418, 422, 424, 428, 433, 447–449, 457, 458, 460, 480, 487, 491  
 transverse, 195  
 propagator renormalization, 148, 149, 153, 155, 368, 370, 377, 488  
 pseudo-Hamiltonian, 352, 357–362, 364–366, 369, 383, 386, 394, 401, 403, 437, 446  
 quantum antiferromagnet, 290, 291  
 quantum critical phenomena, 46, 153, 283, 402, 485  
 quantum critical point, 285, 287, 289–291, 300  
 quantum field theory, 131, 141, 166, 252, 276  
 quantum fluctuations, 267, 284–287, 292, 487  
 quantum statistical mechanics, 46  
 quasi-particle, 267  
 Bogoliubov, 278, 279  
 quasi-static limit, 412, 421, 423, 438  
 quench, 319, 320, 323, 324, 461  
 Résibois-Piette function, 224  
 random walk, 67, 73, 353, 365, 444, 484  
 biased, 68  
 recurrence property, 353, 368  
 rapidity reversal, 404, 407, 418, 420, 421, 423, 438  
 rate equation, 76, 77, 97, 346, 348–356, 361, 364, 367, 368, 371, 373, 378, 383, 386, 394, 401, 413, 415, 427, 437  
 reaction front, 349, 376, 378–381, 383, 386, 393, 395  
 reaction functional, 406, 414, 437  
 reaction noise, 350, 355, 363, 365, 384, 401  
 reaction rate, 346–353, 355, 368, 369, 371, 372, 377, 379–381, 383, 393, 395, 401, 403, 415, 421, 427–431, 433, 436, 438, 439  
 effective, 349, 353–355, 371, 376, 394, 415  
 reaction-diffusion model, 67, 350, 352, 355, 364, 365, 377, 378, 380, 383, 386, 393, 394, 401, 437, 473  
 reaction-limited, 346, 375  
 recombination, 382–384, 386  
 two-species, 385  
 recursion relation, 29, 37–39, 43  
 redundant parameter, 404  
 Reggeon field theory, 401, 404–406, 414, 421, 431, 437, 438  
 relaxation coefficient, 221, 232, 233, 245, 247, 332  
 relaxation constant, 115, 136, 173, 175, 184, 189, 204, 209, 211, 330, 332, 472  
 relaxation rate, 80, 102, 103, 105, 106, 215, 222, 230, 245, 331, 384, 388, 391, 393, 472  
 relaxation vertex, 144, 148, 150, 151, 154, 159, 160, 163–165  
 relaxational kinetics, 56, 76, 91, 98, 101, 115, 123, 131, 136, 193, 208, 322, 323, 330, 333, 336, 342, 380, 384, 444, 461, 470, 472, 474  
 relaxational models, 103, 105–107, 113, 114, 126, 137, 144, 150, 161, 166, 168, 172, 173, 175, 178, 182, 187, 189, 190, 204, 208, 210, 220, 221, 238, 243, 246, 310, 313, 321, 323, 327, 329, 335, 336, 341, 342, 407, 409, 455, 490  
 $O(n)$ -symmetric, 131, 135, 142, 143, 146, 152, 167, 176, 183, 193  
 relevant, 29, 31–33, 37, 119, 124, 174, 177, 238, 271, 289, 311, 368, 417, 423, 428, 430, 432, 436, 475  
 renormalization, 29, 33, 37, 105, 116, 172, 175, 182, 184, 189, 195, 204, 208, 209, 211, 212, 218–220, 223, 230–232, 242, 243, 246, 247, 297, 314, 318, 325, 353, 369–373, 377, 381, 386, 391, 393, 410, 417, 418, 430, 431, 433, 438, 448, 450, 459, 460, 468, 480, 484, 485, 488, 492–494  
 additive, 177, 179, 180, 406, 423  
 multiplicative, 177, 180, 182, 230, 297, 316, 407, 422, 423, 480  
 renormalization constant, 177, 180–184, 187, 189, 200, 204, 210, 214, 219, 220, 222, 230, 231, 245, 246, 297, 314, 316, 407, 408, 414, 423, 429, 433, 439, 450, 477, 480, 481, 484, 493  
 renormalization group, 17, 23, 32, 38, 39, 43, 101, 104, 113, 115, 119, 126, 185, 186, 193, 200, 208, 217, 241, 298, 310, 319, 321, 331, 332, 346, 352, 355, 363, 367, 368, 372, 376, 394, 401, 404, 406, 408, 416, 417, 419, 423, 430, 434, 437, 444, 448, 450, 453, 459, 460, 467, 468, 475, 479, 481, 482, 484, 487–490, 492, 494

## Index

509

- momentum shell, 28, 30, 300
- non-perturbative, 431, 435, 490
- real-space, 426
- renormalization group equation, 175, 185–188, 190, 201, 214, 216, 222, 316, 318, 372, 373, 409, 435, 467, 482
- renormalization group flow, 28, 38, 39, 43, 185, 189, 190, 192, 202, 204, 215, 235, 236, 291, 299, 300, 311, 330, 335, 371, 372, 377, 395, 414, 423, 431, 433, 482, 485, 489, 492
- runaway, 425, 426, 436
- renormalization group transformation, 28, 30–33, 36, 325
- renormalization program, 29, 167, 175–177, 180, 182, 423, 437
- renormalized classical regime, 300
- renormalized parameter, 161, 166, 172, 175, 176, 179, 181, 182, 184–186, 188, 195, 210, 222, 371, 373, 376, 378, 391, 393, 395, 407, 408, 418, 430, 431, 433, 450, 459, 467, 480, 482, 492, 493
- response
  - dissipative, 55
  - reactive, 55
- response field, 133, 134, 137, 138, 142, 143, 145, 147, 150, 151, 166, 168, 196, 316, 330, 366, 388, 389, 407, 432
- response function, 6, 15, 18, 21, 92, 140, 142, 181, 183, 223, 232, 239, 243, 247, 248, 283, 318, 324, 374
  - dynamic, 46, 49, 50, 54, 86, 87, 92, 93, 99, 104, 105, 108, 110, 120, 125, 126, 137, 152, 167, 180, 210, 220, 221, 232, 243, 247, 317, 322, 334, 339
  - longitudinal, 196, 198, 201
  - non-linear, 49
  - transverse, 196
- response functional, 133, 134, 136, 152, 163, 166–169, 173, 181, 193, 197, 209, 218, 228, 260, 330, 336, 337, 365, 383, 387, 404, 420–422, 424, 426, 438, 444, 447, 458, 466, 475, 488
- response loop, 135, 141–144, 150, 163, 168
- response propagator, 105, 109, 110, 112, 135, 137, 139, 140, 143, 144, 147, 148, 150–156, 160, 162, 163, 165, 312, 314, 315, 322, 404
- reversible force, 91, 112, 115, 116, 118, 127, 131, 168, 217, 226, 227, 238, 239, 318, 339, 342, 453, 472
- rigidity, 290
- rotation group, 122, 136, 219, 226
- rotational invariance, 28, 39, 42, 43, 117, 118, 122, 136, 137, 162–164, 174, 196, 202, 208, 222, 223, 226, 273, 276, 291, 292, 294, 298, 326, 328, 329, 336, 485
- roughening transition, 476, 479, 483–485, 487–490
- roughness exponent, 474–476, 485, 489, 492, 494
- running coupling, 38, 43, 185, 188, 191, 192, 202, 214, 297, 371, 373, 430
- saddle point approximation, 266, 339
- Sasvári–Schwabl–Szépfalusy model, 126, 217, 226–229, 231–233, 235, 236, 241, 244, 247, 329–332
- scale invariance, 28, 29, 38, 135, 174, 182, 185, 189, 325, 352
  - local, 329
- scale transformation, 29, 30, 36, 123, 175, 189, 191, 297, 325, 447, 450, 477, 487
- scaling dimension, 172, 173, 176, 187, 192, 201, 204, 209, 219, 230, 241, 297, 311, 332, 354, 368, 372, 380, 403, 414, 418, 420, 424, 427, 428, 434, 437, 449, 459, 475, 490, 491
- anomalous, 190–192, 201, 204, 222, 243, 297, 429, 433, 439, 447, 450, 455, 460, 468, 493
- scaling exponents, 26, 29, 31, 98, 178, 182, 191, 219, 286, 324, 334, 369, 395, 401, 432, 444
- conserved KPZ equation, 491, 492, 494
- directed percolation, 411, 412, 416, 426
- driven diffusive systems, 448, 449, 452, 455, 459, 468
- Edwards–Wilkinson model, 474, 476, 479
  - effective, 381, 382, 454
- Kardar–Parisi–Zhang equation, 469, 474, 475, 477, 478, 481–484, 490, 494
- long-range KPZ equation, 494
- mean-field, 380, 449, 453
- scaling form, 24, 33, 99, 105, 121, 126, 190, 285, 320, 323, 324, 334, 380, 395, 410–412, 449, 450, 453, 455, 457, 458, 461, 466, 468, 474
- scaling function, 24–27, 98–100, 113, 172, 183, 191, 223–226, 317, 321, 329, 330, 372, 380, 411, 412, 453, 455, 464, 484
- scaling hypothesis, 24, 290, 328, 329, 402, 455, 477
- scaling law, 28, 33, 99, 100, 119, 199, 224, 317, 321, 324, 332, 336, 348, 380, 401, 408, 409, 411, 436, 444, 459, 461–464, 493
- scaling regime, 27, 100, 236, 248, 461, 469, 490
  - dynamic, 115, 214, 216, 217, 233, 235, 238
- scaling relation, 23–25, 33, 105, 115, 124, 181, 182, 191, 195, 199, 204, 217, 222, 223, 233, 235, 244, 246, 248, 271, 290, 319, 325, 334, 410, 416, 476, 477, 482, 488, 489
- scaling theory, 23, 26, 119, 124, 208, 217, 234, 289, 321, 325, 346, 353, 372, 417, 456, 469, 473, 476, 487
- scaling variable, 24, 26, 32, 99, 100
- scattering vertex, 368, 369, 429
- Schrödinger equation, 46, 56, 62, 87, 252, 255, 357, 362, 487
  - non-linear, 272
- Schrödinger picture, 47
- second law of thermodynamics, 338
- second sound, 126, 237
- self-energy, 154–156, 158, 223, 296, 302, 314, 315, 322, 389, 390, 395, 406, 407, 448, 449
- semi-group, 29
- shear mode, 240

- short-time expansion, 317, 456  
 sine-Gordon chain, 473  
 single-mode laser, 87, 94  
 singularities, 13, 19, 22, 34, 173, 176, 177, 180, 191, 193, 199–201, 270, 271, 273, 285, 287, 370, 407, 410, 417, 448, 455, 457  
 infrared, 23, 28, 172, 177, 178, 182, 185, 193, 202, 370, 393, 451, 480, 484  
 thermodynamic, 14, 16, 23, 26  
 ultraviolet, 484  
 Slater determinant, 261  
 slow variable, 115, 116, 131, 132, 329, 330, 406  
 Smoluchowski equation, 85, 87, 93  
 Smoluchowski theory, 346, 353–355, 367, 369, 372, 376, 394  
 soliton, 477, 493  
 sound speed, 273, 278  
 sound wave, 240  
 source term, 34, 111, 156, 157, 194–196, 318, 373, 388, 404, 406, 448  
 specific heat, 9, 13, 19, 22–25, 41, 43, 114, 121, 125, 208, 216, 270, 271, 335  
 spectral representation, 48, 54  
 spherical model, 199, 319, 321–325, 341  
 spin wave, 121, 125, 127, 224, 225, 237, 388  
 spin wave damping, 125  
 spin-statistics theorem, 252  
 spinodal decomposition, 320  
 spontaneous magnetization, 11, 12, 43, 120, 122, 200, 287  
 spontaneous symmetry breaking, 11, 117, 193, 194, 196, 199, 236, 273, 281, 286, 290, 292, 298, 393  
 stability matrix, 215, 234, 235  
 stability regime, 215, 235  
 staggered magnetization, 126, 127, 226, 236, 292  
 state vector, 62, 357, 359, 360  
 stationary state, 61, 63, 65, 76, 94, 274, 336, 348, 350, 353, 379, 380, 383–385, 413, 415, 425, 427, 444, 453, 457, 475, 493  
 statistical weight, 132, 134, 136–138, 173, 257  
 statistically independent, 58, 68, 348  
 steepest-descent approximation, 322  
 stiffness exponent, 28, 325, 487  
 stochastic differential equation, 77, 78, 86, 89, 103, 116, 119, 127, 131, 227, 260, 377, 414, 432, 444, 457, 472  
 stochastic force, 77–80, 84, 90, 101, 104, 111, 131, 136, 208, 228, 356, 365, 405, 466, 473  
   Gaussian, 102  
 stochastic process, 56, 57, 60, 64, 67, 68, 71, 73, 81, 88, 90, 131, 138, 166, 168, 346, 349, 352, 355, 359, 361–364, 381, 383, 386, 393, 401, 403, 405, 414, 425–427, 436, 437, 453, 457, 466, 474  
   Gaussian, 59, 78, 92  
 irreversible, 61  
 Markovian, 58, 59, 61, 66, 67, 69, 71, 74, 83, 90, 92, 319, 339, 405, 406  
   stationary, 57  
   uncorrelated, 58  
 stretched exponential, 377  
 strong-coupling regime, 335, 476, 479, 484, 489  
 structure factor, 48, 279, 321, 327, 448, 457, 458  
 structure formation, 386, 391, 393  
 sum rule, 56, 92  
 Sun–Gao–Grant model, 491, 494  
 superconductor  
   type-II, 486  
 superdiffusive, 374, 395  
 superfluid, 126, 235, 236, 266, 271, 273, 275, 282, 283, 289, 302  
 superfluid density, 267, 282, 283, 289, 293  
 superfluid flow, 274, 275  
 superfluid velocity, 273, 274  
 supersymmetric quantum mechanics, 88  
 surface critical phenomena, 310  
 surface growth, 469, 472–474, 476, 478, 479, 489–491  
 survival probability, 71, 73, 74, 93, 97  
 susceptibility, 107, 121, 125, 179, 180, 182, 184, 221, 223, 231, 233, 341  
 dynamic, 46, 49–52, 55, 92, 99, 105, 109, 137, 161, 168, 181, 190, 197, 198, 201, 221, 231, 233, 243, 245, 247, 311, 316, 458  
 isothermal, 12, 13, 15, 18, 19, 25, 27, 33, 41  
 linear, 52, 53  
 longitudinal, 198–201, 226  
 mixed, 125, 230  
 non-linear, 220, 230  
 thermodynamic, 54, 196, 199  
 transverse, 121, 125, 196, 197, 292, 293  
 symmetry-breaking field, 10, 17, 117, 292  
 thermal conductivity, 114, 209, 236, 240  
 thermal de Broglie wavelength, 268, 276, 277  
 thermal equilibrium, 6, 7, 18, 47, 64, 77, 80, 84, 86, 98, 101, 219, 313, 319, 329, 332, 336, 348, 350, 352, 426, 445, 448, 452, 457, 465, 469–471, 473, 476, 480, 482, 485, 492  
 thermodynamic limit, 8, 16, 26, 28, 42, 74, 268, 269, 285, 319, 350, 352, 367, 386, 401, 428, 466  
 thermodynamic stability, 7, 13, 18, 19  
 thermodynamics, 10, 13, 20, 26, 121, 157, 267, 287  
 tilt invariance, 477, 480, 482, 485, 493  
 time domain, 107, 110, 151, 165, 166, 169, 259, 284, 285, 289, 314, 370, 394, 422, 438  
 time evolution operator, 46, 255  
 time inversion, 137, 160, 336, 337, 404  
 time scale separation, 77, 80, 91, 101, 380  
 time translation invariance, 47, 57, 65, 78, 81, 105, 111, 138, 150, 176, 310–312, 314, 455, 456, 463  
 time-dependent Ginzburg–Landau equation, 102  
 time-ordered product, 53, 255, 258  
 time-temperature superposition, 100  
 topological defect, 274, 320, 325–327, 479  
 topological quantum number, 275  
 transition probability, 59, 61, 65, 66, 69, 83

Cambridge University Press

978-0-521-84223-5 - Critical Dynamics: A Field Theory Approach to Equilibrium and Non-Equilibrium Scaling Behavior

Uwe C. Täuber

Index

[More information](#)*Index*

511

- transition rate, 60, 64, 65, 71, 74, 76  
     time-independent, 61, 63, 67, 92
- translational invariance, 10, 15, 22
- transport coefficient, 282, 289
- transverse fluctuations, 120, 122, 124, 195, 196, 198, 202, 236, 292, 295, 341
- tree level, 149, 160, 163, 164, 180, 372, 374, 466
- tricritical point, 19, 42, 104, 438
- Turing instability, 352
- ultraviolet cutoff, 22, 30, 141, 173, 175, 179, 183, 275, 295, 328, 355, 431, 467
- uniaxial anisotropy, 122, 333
- universality, 6, 8, 14, 27–29, 34, 38, 39, 100, 114, 118, 190, 191, 241, 267, 291, 300, 311, 317–319, 321, 330, 355, 364, 371, 373, 374, 401, 404, 405, 422, 426, 428, 435, 444, 455, 459, 463, 468, 479, 490
- universality class, 23, 29, 34, 239, 271, 277, 289, 331, 335, 350, 401, 404, 406, 411–414, 422, 424, 426–429, 432, 434, 436, 476, 478, 490  
     dynamic, 99, 102, 113, 124, 330
- vacuum contribution, 141, 143
- van-der-Waals gas, 6–8, 12, 18, 41, 239
- vapor pressure curve, 8, 9, 41
- vector potential, 239
- velocity correlations, 80
- vertex, 142, 144, 146, 150–153, 159, 163, 165, 167, 168, 209, 211, 229, 241, 243, 260, 278, 311, 334, 368–370, 372, 374, 388, 404, 422, 448, 455, 458, 480, 491  
     four-point, 111, 142, 150, 151, 154, 164, 165, 194, 260, 296, 315, 389, 404, 406, 414, 421  
     six-point, 296  
     three-point, 194, 209, 210, 218, 278, 389, 404, 406, 448, 480, 491  
     two-point, 111, 142, 150, 152, 160, 163–165, 169, 184, 210, 406  
     vertex factor, 223, 242, 248, 293
- vertex function, 154, 156, 159, 161–166, 169, 176, 177, 179, 182, 183, 185, 188, 189, 196, 200, 210, 214, 220, 230, 231, 242–244, 247, 314, 334, 369, 406, 407, 409, 450, 493  
     *N*-point, 157, 162, 163, 165, 175, 181, 186, 187, 204, 210, 230  
     four-point, 162–164, 166, 169, 172, 176, 177, 184, 439, 488  
     three-point, 212, 213, 244, 247, 248, 407, 418, 422, 438, 480, 492, 493  
     two-point, 157, 160, 161, 169, 175, 176, 180, 181, 190, 199, 210–212, 220, 221, 231, 232, 244, 246, 248, 296, 302, 390, 391, 406, 407, 409, 418, 422, 438, 448, 449, 451, 460, 480, 484, 494
- vertex renormalization, 149, 154, 160, 314, 369, 377, 484
- viscosity, 240, 242, 274
- voltage correlations, 93
- voltage noise, 93
- von-Neumann equation, 56
- vortex, 174, 274, 275, 326, 327
- vorticity, 282, 452
- vorticity correlations, 282
- voter model, 432
- waiting time, 311, 455, 462
- Ward identity, 162, 196, 219, 230, 243, 247, 248, 450, 459, 480, 493
- weak-coupling regime, 475
- Wentzel–Kramers–Brillouin method, 361
- Wick rotation, 287
- Wick’s theorem, 34, 36, 37, 108, 110, 126, 140, 147, 198, 266, 281, 302
- Wiener–Khinchine theorem, 79
- Wilson’s flow function, 186, 190, 201, 214, 233, 246, 299, 316, 408, 419, 433, 452, 482
- Wolf–Villain model, 491, 494
- XY model, 113, 123, 136, 174, 218, 267, 277, 281, 300