

Index

- anti-Zeno effect (AZE), xii, 134, 135, 137, 139, 141, 144, 146–152, 156–161, 205, 281, 284, 289, 303, 365, 371–378, 380, 429, 434, 449, 451
- AZE, *see* anti-Zeno effect
- bath spectral filtering (BSF), 435–448
- bath-optimized task-oriented control (BOTOC), 200–210, 215, 216, 242, 450
- bosonic baths, 22–24, 43, 54, 83, 110, 111, 118, 168, 182, 192, 193, 269, 431
- BSF, *see* bath spectral filtering
- canonical density operator, 3
- canonical ensemble, 10, 11
- collective coupling, 80, 109, 113, 226, 394
 - to a single field-mode, 80
- collective energy currents, 386–387
- commensurate-frequency spectrum, 12
- continuous cycles, 326, 343, 346–364, 427
- control of steady states, 288–300
- cooling speed, 453
 - scaling with temperature, 430–432
- cooperative decay, 80, 83, 85, 88, 92
- cooperative emission, 85, 94
- cooperative power enhancement, 387–392
- correlation, 19, 39, 49, 69, 86, 88, 92, 126, 154, 156, 221, 223, 224, 226, 261, 272, 273, 306, 308, 311, 318, 320, 321, 324, 378, 380, 449, 451
- correlation energy, 318, 320, 322, 324
- correlation function, 19, 49, 55, 56, 139, 166–168, 178, 179, 181, 185, 188–191, 204, 220, 246, 251, 379
- correlation matrix, 204
- correlation spectrum, 237
- correlation time, 115, 116, 126, 141, 142, 169, 176, 186, 188, 194, 208, 209, 223, 227, 231, 232, 237, 239, 240, 246, 256, 281, 285, 287, 299, 303, 321, 322, 324, 350, 365, 367, 384, 450
- decay modified by measurements, 138, 140
- decoherence, xii, 39, 110, 112–115, 119, 120, 125–133, 195, 196, 199, 217, 221–225, 227, 229–231, 234, 237, 239, 240, 242–245, 248, 249, 305, 346, 449, 450
 - control, 161, 182, 186, 198, 205, 207, 211, 217, 218, 221–226, 228, 229, 231–236, 238–241, 450
 - non-Markovian, 239
 - factors, 226, 228, 230–232, 235
 - matrix, 219–222, 224, 225, 228
 - protection from, 215
 - rate, 111, 116, 190, 196, 205, 207, 225, 229, 231, 233–237
 - suppression, 161, 196, 198, 210, 219, 224, 240, 449
- decoherence-free subspace (DFS), 221, 222, 226, 240
- decoherence-free system, 221
- defect mode, 65
- detailed balance, 13
- DFS, *see* decoherence-free subspace
- dipole–dipole interactions, xii, 91, 93, 103, 106, 117, 447, 448
- driven quantum system, 259–271
- dynamical control, xi–xiii, 22, 161, 192, 195–198, 205, 210, 211, 217, 221, 224, 241, 242, 249, 250, 252, 254–256, 324, 450, 451, 453
- dynamical decoupling (DD) control, 192–194, 196–198, 206–210, 240, 450
- eigenstate thermalization hypothesis (ETH), 3, 11, 451
- electron–phonon interactions, 45, 47, 348
- engine performance, 340–342
- entangled system–meter states, 121, 125, 126
- entanglement, 91, 101–103, 112, 117, 118, 199, 226, 233–235, 238, 239, 241, 333, 338, 342, 393, 394, 450, 452
 - between the system and the meter, 125
- entanglement between the system and the bath, 69, 73, 132, 261, 276, 303, 321

near thermal equilibrium, 69
 entropy, 4, 5, 18, 259–263, 266–272, 276, 279, 283,
 284, 289–291, 296, 297, 303, 304, 307–452
 conditional, 308
 linear, 300–302
 Shannon, 307, 309, 310, 323
 von Neumann, 128, 132, 273, 307, 318, 352
 entropy production, 259, 261–263, 267, 268, 284,
 307, 311, 323, 380, 397, 398, 408, 411, 419, 423,
 424, 426
 partial, 267
 total, 261, 269
 equilibration, 3, 6, 7, 10, 12, 15, 16, 79, 288, 298, 303
 equilibrium, 3, 5, 10, 11, 13, 15, 18, 19, 48
 system evolution toward, 77
 thermal, 3, 15, 19, 20, 49, 50, 69, 70, 73–77, 79,
 168, 259, 262, 263, 272, 273, 277, 278, 281, 283,
 288, 289, 295, 297, 303, 307–309, 319, 323, 332,
 450, 451
 equilibrium ensemble, 6, 8, 11
 ergodicity, 3, 309
 ergotropy, 265, 266, 268, 269, 271, 315, 325–333,
 341, 342, 395–398, 406, 407, 409, 410, 414,
 417–419, 421, 426, 452
 ETH, *see* eigenstate thermalization hypothesis
 Euler–Lagrange optimization, 198–200, 246, 251

 filter-function control, 194, 195, 208, 209, 253, 286
 filtered bath, 441
 spectra, 368–371, 443, 445

 generalized Gibbs ensemble (GGE), 11, 12
 GGE, *see* generalized Gibbs ensemble

 HD, *see* heat diode
 HE, *see* quantum heat engine
 heat currents, 266–270, 318, 346, 352–353, 357, 359,
 363, 366–368, 370–374, 378, 379, 386–389, 391,
 398, 404, 411, 416, 424, 427–431, 434, 438–440,
 443–445, 447
 heat diode (HD), xiii, 435–442, 446–448
 heat exchange, 264–266, 268, 269, 323, 330, 332,
 333, 371, 406
 heat transistor (HT), xiii, 435, 436, 442–448
 heat-flow rectification, 435–448
 heat-to-work conversion, 366, 395–421, 452
 heat-transistor amplification, 442–446
 hybrid systems, 242–256, 450
 hypothesis of quantum typicality, 11

 information feedforward, 312–318
 integral of motion, 11
 irreversibility, 3, 19, 451, 452
 irreversible quantum dynamics, 55, 57, 62, 68, 149,
 158, 160, 227, 307, 323, 449

Lamb shift, 58, 59, 63, 65, 76, 104, 167, 170, 171,
 173, 185, 276, 369, 440, 447, 448
 cooperative, xii, 86, 87, 92–94, 96, 99, 109, 111,
 113, 225
 Landauer principle, 306, 309–311, 318–322, 324
 level population, 6–8, 10, 16, 17, 51, 61, 62, 65, 70,
 73, 100, 138–142, 145, 149, 150, 161, 172, 173,
 178, 220, 221, 223, 226, 227, 245, 247, 248, 263,
 274, 277–279, 282–284, 291, 298, 299, 318, 319,
 322, 334–337, 339, 350, 358, 368, 385, 387, 395,
 398, 399, 404, 405, 411, 412, 419, 425, 438, 442
 Liouville–von Neumann equation, 16, 201

 macroscopic quantum-superposition (MQS), 109,
 113–116, 118
 magnon baths, 36, 54, 422, 432, 453
 two-level system coupling to, 52, 53
 many-body permutation symmetry, 87, 381–385
 master equation (ME), 137, 154, 172, 176, 178, 182,
 184, 189, 190, 193, 228, 261–263, 269, 279, 282,
 283, 292, 328, 331, 334–337, 350, 355, 363, 366,
 367, 383, 390, 414, 415, 430, 437, 439, 442
 cooperative, 383–386
 Floquet approach to, 349, 367
 Lindblad, 261, 272, 349, 350, 383, 384, 403–405
 Markovian (MME), 169, 176, 261, 270, 272, 349,
 350, 367, 384, 393
 non-Markovian, 161–182, 195–197, 228, 261, 279,
 352, 450
 quantum optical, 177
 ME, *see* master equation
 mean energies at equilibrium, 74, 76
 mean energy, 18, 264, 275, 276, 279, 319, 405, 406,
 408, 409, 425, 426
 microcanonical
 ensemble, 3, 10, 11
 formalism, 10
 minimal QHM model, 366, 378, 371–378
 modulation
 periodic, 170, 318, 320, 346–353, 356, 366–371,
 382
 quasiperiodic, 188, 194, 234, 239
 multipartite coherence (entanglement), 112
 control, 217–241
 multipartite open system, 80–90, 242
 control, 250

 non-ergodicity, 309
 non-Markovian
 cooling, 279–288, 295, 304
 cycle, 319–322, 324, 371–374, 376
 “freezing” the initial state, 298
 heating, 279–288
 non-Markovian bath, 287, 373
 non-Markovian baths, 244, 246, 248
 non-Markovian effects, 167, 231, 238, 272, 289, 366,
 372

- non-Markovian equilibration, 79
- non-Markovian evolution, 161, 176, 268, 270, 279, 290, 297, 304
- non-Markovian noise, 255
- non-Markovian processes, 259–263, 272
- non-Markovian regime, 115, 256, 289, 304, 353, 365, 427, 434
- non-Markovian timescale, xii, xiii, 115, 196, 229, 234, 235, 238, 240, 241, 280, 284, 285, 318–320, 324
- nonpassivity, xiii, 263, 271, 341, 395, 398, 405, 407, 410, 413, 419, 421
- nonthermal baths, xii, 325, 327–340, 342
- nonthermalization, 20, 21, 451
- occupation probability, 5, 9, 10
- open systems, xi, 3, 138, 157, 158, 160, 205, 242, 256, 259, 260, 290, 295, 449, 450
- optimal dynamical control, 198–210, 248–256
 - non-Markovian, 244
- optimized control of quantum state transfer, 242–256, 450
 - between multipartite open-system subspaces, 242–243
 - from noisy to quiet qubits, 243–248
 - through noisy quantum channels, 248–256
- Otto cycles, 343–346, 353, 354, 356, 360–362
 - efficiency, 361, 362
 - limit, 356, 358
 - modified, 328–332
- partial decay, 21, 57
- passivity, 263, 341, 345, 405, 407, 416, 417
 - complete, 264
- periodically modulated TLS in thermal bath, 170, 348, 365–367, 371, 378, 383, 422, 434
- permanent oscillations, 6
- photon interactions with optical phonons, 33
- photon–atom binding, 57
- photonic band gaps (PBGs), 29, 34, 35, 58, 59, 68
- photonic bands, 29, 160
 - edges, 56, 68
- photonic bath, 24, 44, 45, 54, 55, 57, 83, 91, 141, 177, 178
- piston squeezing, 414–418
- Poincaré recurrence, 6
- pointer, 119, 122, 124, 125, 127, 133
 - basis, 119, 122–125, 129, 132, 133, 276, 304
 - standard (SP), 119, 121, 122, 124–127, 130–133
 - states, 119, 125, 127, 132, 289, 304, 419
- pointer basis, 121
- polaritons, 23, 33, 35, 39
- polaron, 47, 50, 51, 54
- polaron transformation, 45, 48
- polaronic system–bath interactions, 44, 48
 - opto-mechanical, 44, 45
- prethermalize, 12
- QHM, *see* quantum heat machines
- QHM catalysis, 395, 414–418, 420
- QND impulsive disturbances, 272, 273, 279, 283, 287–300
- quantum computation, 211–241, 450
- quantum dynamics, 3, 55–68, 118, 276, 303
- quantum heat engines (HE), 343, 353, 355, 357–360, 362–364
 - cyclic, 325–342
 - many-body, 381–383
 - reciprocating, 344–346
 - two-level minimal model, 365–380
- quantum heat machines (QHM), xii, xiii, 322, 328–340, 342–380, 429, 430, 451, 452
 - cooperative, 381–394
 - fully quantized, 395–421
- quantum heat manager, xiii, 435–448
- quantum information, xi, 128, 450
 - processing, xii, 211–241, 453
 - storing, xii
 - transferring, xii
- quantum measurements, xii, xiii, 7, 8, 12, 119–133, 260, 273–281, 283, 299, 306, 312, 318–323
 - frequent QND, 272, 274, 276, 281, 283–285, 288, 296, 303, 304, 308, 318, 320, 322, 323, 451
 - frequently repeated or continuous, 134, 136–138, 140–145, 147–160, 195, 205, 272, 283–300, 303, 304, 324, 449–451
 - homodyne, 312, 313, 318
 - von Neumann model, 119, 120
- quantum quench, 7
- quantum refrigerator
 - semiclassical minimal, 422, 427–434
- quantum refrigerators, xiii, 328, 330, 353, 357, 360, 361, 363, 365–368, 370, 378, 382, 391, 422–434, 453
- quantum Zeno effect (QZE), xii, 134, 136–146, 148–154, 156–161, 205, 278, 280, 281, 284, 289, 290, 298, 303, 304, 378, 380, 449, 451
- quantumness, xii, 340–342, 365, 421
- qubit meter, 124, 130
- QZE, *see* quantum Zeno effect
- RDDI in waveguides, 91, 99–102, 117, 118
 - non-Markovian theory, 101–103
- recurrence, 6, 11, 13
 - partial, 12
- reversibility, 3, 55, 68, 325, 340, 341, 370, 423, 450, 452
- self-energy, 58, 62, 225
 - cooperative, 91, 92, 94, 97, 103, 117
- SP, *see* standard, pointer
- spectral filter function, 174, 186, 206
- speed limits, 353, 355, 357, 358, 360–362, 364, 370, 452
 - quantum, 427, 453

- spin baths
 - two-level system coupling to, 52
- spin-boson models, 40, 69, 196, 400, 403
- spin–spin coupling, 38, 53
- Srednicki, 3, 11
- steady-state cycles, 343–364, 380
- system–bath correlations, 306–324, 378, 449, 451
 - non-Markovian, 318–322
- system–bath non-separability, 17, 69, 73, 74
- system–bath reversible dynamics, 15, 55, 68, 149, 160, 262, 304
- system–bath separability, 17, 451
- thermalization, 3, 10, 12, 14, 20, 21, 305, 419, 426, 430, 450, 451
 - resilience against/to, 397, 408, 419, 421, 422, 425
 - time for, 346, 350, 375
- thermalization stroke, 344
- thermodynamics, 3, 259, 272, 306, 325, 332, 364, 421, 451–453
 - first law of, 259, 266, 270, 323, 324, 327, 333, 346, 353, 366–368, 438
 - information, 324
 - second law of, 259, 260, 267, 270, 306–311, 319, 323–326, 328, 332, 333, 341, 346, 352, 359, 363, 367, 378, 396, 397, 403, 424, 452
 - third law of, xiii, 5, 422–434
 - zeroth law of, 18
- time arrow, 13
- time-inversion symmetry, 3, 12, 13
- TLS cooling control, 300–303
- TLS heating, 283–288
- two-level quantum amplifier, 398–413
- universal efficiency bound, 325–328
- von Neumann, 3, 119, 120
 - projection postulate, 449
 - quantum ergodic hypothesis, 450
- Wigner–Weisskopf dynamics, 55, 68
- work, xiii, 259, 263–266, 271, 303, 325–327, 329, 330, 341, 344–346, 353, 358–360, 366, 370, 380, 423, 424, 430, 433
 - capacity, 271
 - extraction, 264, 310, 312–318, 320–324, 327, 341, 346, 366, 371, 378, 395–398, 400, 405–413, 415, 419, 420, 422, 424, 426, 433, 452
 - reservoir, 329, 330, 366
 - source, 330
 - store, 424
- work–information relation, 306–324, 452