

Index

- aberration, 414
- acceleration, 67, 73
- acoustic peaks, 97, 109, 331
- acoustic term, 97
- action, 132, 133
- action, Hilbert, 422
- angular momentum, 432
- anisotropic stress tensor, 71
- anisotropy, CMB
 - dipole, 29
 - quadrupole, 208
- axion, 44
- background geometry, 3
- Bardeen equation, 80
- Bardeen potentials, 69
- baryon
 - abundance, 42
 - density, 42
- Bayes' theorem, 345
- Bessel functions, 450–452
 - modified, 451
 - spherical, 225, 451
- Bianchi identities, 6, 421
- bias, 100, 296
 - evolution, 311
 - magnification bias, 303
- big bang, 8
- big crunch, 8
- big rip, 6
- binding energy of hydrogen, 18
- bispectrum, 147, 245
 - CMB, 251
 - local, 248
 - from nonlinearities, 250
- Boltzmann equation, 25, 166, 186, 187, 188, 232
- central limit theorem, 462
- chemical potential, 17, 27, 409
- Christoffel symbols, 420, 425, 427, 428
- Clebsch–Gordan coefficients, 223, 434–436
- Clebsch–Gordan decomposition, 433
- Clebsch–Gordan series, 433
- CMB anisotropies, 92, 163–207
- COBE satellite, 29
- Coleman–Weinberg potential, 50
- collision integral, 25
- collision term, 218, 220
- Coma cluster, 411
- commutation relations, 136
- comoving gauge, 80
- Compton scattering, 389
- Compton y parameter, 27, 410
- conformal time, 3
- correlation function, 348
- cosmic microwave background, CMB, 27
- cosmic string, 113
- cosmic variance, 99
- cosmological constant, 5, 6, 45
- cosmological model, 350
- cosmological parameters, 329–387
- cosmological principle, 2
- covariant derivative, 420, 421
- critical density, 418
- curvature, 3-space of constant, 3
- curvature perturbation, 81
- dark matter, 44
- decoherence, 120
- decoupling of photons, 14, 20, 23
- deflection angle, 269
- density
 - critical, 7
 - entropy, 15
 - parameter, 7, 418
 - particle, 15
- deuterium, 40
 - abundance, 42

Index

499

- distance
 - angular diameter, 9, 11, 109
 - luminosity, 13
- distances, cosmological, 8
- distribution, 461
 - Gaussian, 462
 - marginalized, 362
 - normal, 462
 - standard normal, 462
- distribution function, 25, 163, 164, 461
- DMR experiment, 29
- domain walls, 115
- Doppler term, 97
- Einstein equations, 5, 74, 421
- Einstein tensor, 5, 421, 426, 428, 429
- energy condition, strong, 8, 46
- energy conservation, 6
- energy density, 5, 70
- energy flux, 70
- energy momentum tensor, 5, 422
 - perturbations of, 70
- entropy per baryon, 16
- entropy density, 418
- entropy flux, 454
- entropy perturbation, 3
- entropy problem, 46
- entropy production, 458
- ergodic hypothesis, 99
- error, marginalized, 357
- Euler angles, 223
- evidence, 349
- expansion, 67
- expectation value, 461
- Fermi constant, 33
- Fermi Dirac distribution, 163
- Fisher matrix, 354, 360
- flat sky approximation, 215, 229
- flatness problem, 46
- flux, 13
- fractal, 2
- freeze out (of a reaction), 20
- Friedmann, 3
- Friedmann equations, 5, 6
- Friedmann metric, 423
- Friedmann–Lemaître universe, 4
- fundamental constants, 417
- galaxy cluster, 410, 411
- gauge invariance, 61, 63
- gauge transformation, 61, 62, 71
- Gaunt factor, 396
- Gaunt integral, 440
- geodesic, 420
- Gibbs potential, 17
- Gibbs relation, 454
- gravitational waves, 335
- gravitino, 44
- growth function, 101, 316, 317, 376
- Gunn Peterson trough, 336
- Hankel functions, 450
- harmonic analysis, 63
- Harrison–Zel'dovich spectrum, 104, 135
- heat conductivity, 457
- heat flux, 455
- helicity, 213
- helium, 16
 - abundance, 35
 - helium-3 abundance, 42
 - helium-4 abundance, 41
- Higgs field, 112
- homogeneity, 2
 - statistical, 98, 245, 258
- horizon, 45
- horizon problem, 45
- Hubble, 8
- Hubble constant, 9, 417
- Hubble parameter, 6
- inflation, 44, 46, 130, 135
 - consistency relation, 145
 - e-foldings of, 51
 - energy scale of, 144
 - large field, 49
 - power law, 137
 - slow roll, 47, 131, 132, 139, 145
 - small field, 50
 - tensor perturbations, 141
 - vector perturbations, 140
- inflaton, 46
- intensity, 210
- invariant measure, 164
- ionization, final, 20, 22
- ionization fraction, 18
- isocurvature perturbations, 159
- isotropy, 2
 - statistical, 98, 245
- kinetic theory, 163
 - relativistic, 163
- Kompaneets equation, 389, 393
- Lagangian, scalar field, 46
- large-scale structure (LSS), 296–328
- Legendre functions, 431
- Legendre polynomials, 221, 430
- Lemaître, 4
- lens map, 271
- lensing, 268
 - power spectrum, 272
 - shear, 272
- lensing of the CMB, 268–295
- lensing of LSS, 302
- Lie derivative, 62, 422

likelihood, Bayesian, 349
 likelihood function, 348
 Liouville equation, 25, 165
 lithium-7, abundance, 42
 longitudinal gauge, 69
 Lorentz invariance, 4
 luminosity, 13
 Lyman- α
 clouds, 336
 forest, 336, 379
 magnitude, 303
 Markov chain, 362
 mass-bundle; *see* mass-shell
 mass-shell, 164
 Mathieu equation, 54
 Maxwell–Boltzmann distribution, 18
 Megaparsec, Mpc, 2
 metric, 3
 metric, pseudo-Riemannian, 420
 Metropolis-Hastings algorithm, 364
 Mészáros effect, 91
 Minkowski functional, 263
 monopole problem, 46
 monopoles, 114
 Monte Carlo, 366
 Hamiltonian, 366
 Markov chain, 362
 N-point function, 258
 connected, 258
 neutrino, 15, 26, 33, 35, 42, 163
 decoupling, 33
 neutron
 density, 35
 lifetime, 38
 noise, 358
 non-Gaussianity, 244, 374
 nucleosynthesis, 29
 number count fluctuation, 297
 Occam's razor, 350
 parallel transport, 421
 parity, 212
 Pauli matrices, 210
 perfect fluid, 77
 perturbation, 425
 equations, 74
 scalar, 425
 tensor, 428
 vector, 121, 427
 phantom matter, 6
 phase space; *see* mass-shell
 phase transition, 112
 pivot scale, 102, 140, 372, 374
 Planck data, 259, 265
 Planck distribution, 16

Planck mass, 32, 417
 Planck satellite, 104, 360
 polarization, 208–243
 B-mode, 212, 225, 242, 335
 circular, 210
 curl type, 214
 E-mode, 212, 225, 242
 gradient type, 214
 linear, 210
 posterior, Bayesian, 349
 posterior distribution, 349, 365
 power spectrum, 98, 137, 225
 CMB, 190
 dark matter, 100
 polarization, 227
 preheating, 54
 pressure, 5
 primordial black holes, 44
 prior, 349
 probability distribution; *see* distribution
 quantization, 136
 quasar, 336
 random variable, 461
 Gaussian, 462
 independent, 462
 recombination, 14, 17, 19
 redshift, 9
 cosmic, 9
 redshift space distortion (RSD), 297
 reheating, 52, 54
 reionization, 336, 412
 resonance, 54
 Ricci tensor, 421, 426, 428, 429
 Riemann scalar, 421, 426
 Riemann tensor, 421, 425, 427, 429
 Robertson, 4
 Rodrigues' formula, 430
 rotation group, 432
 irreducible representations of, 432
 Sachs equation, 482
 Sachs–Wolfe effect, 96
 integrated, 104
 ordinary, 96
 Saha equation, 18
 sampling, 363
 scalar field, 46, 128
 scale factor, 3
 scale invariance, 100, 102, 104, 135
 scattering matrix, 218
 scattering plane, 218
 second-order action, 134
 seeds, 112
 causal scaling, 115
 shear, 67, 72
 shear, of the energy momentum tensor, 457

Index

501

- shot noise, 315
sigmag, 376
Silk damping, 200–202, 407
Silk damping scale, 409
sources, 112
spatial curvature, 68
spectral index, 102, 138
spectrum; *see* power spectrum
spherical harmonics, 432, 435–443
 addition theorem for, 438
 spin weighted, 212, 443–449
 addition theorem for, 445
spin raising/lowering operator, 446
squeezed limit, 149
standard deviation, 461
Stefan–Boltzmann constant, 14
Stewart–Walker Lemma, 63
Stokes parameters, 209
stress tensor, 70
Sunyaev–Zel'dovich effect, 410
supernova, 384
symmetry breaking, 112, 113
thermal equilibrium, 14, 163
Thomson cross section, 187
Thomson scattering, 16, 187, 208, 210
 angular dependence of, 187
time, cosmic, 3
topological defects, 112
topology, 4
total angular momentum decomposition,
 220
transfer function, 98, 253, 273, 329
trispectrum, 258
 CMB, 260
unimodular gauge, 133
units, 416
vacuum manifold, 112
variance, 461
vector gauge, 69
viscosity
 bulk, 457
 shear, 457
vorticity, 67, 72
Walker, 4
weak interaction, 37
Weyl potential, 269
Weyl tensor, 69, 422, 426, 428, 429
Wick's theorem, 463
Wigner 3J symbols, 439
Wigner symbol, generalized, 443