

Index

- action
 - Dirac–Born–Infeld (DBI), 236
 - Nambu–Goto, 91, 497
 - point particle, 72–73
 - Polyakov, 73–74, 91–92, 490
 - Ramond–Neveu–Schwarz, 106
 - Wess–Zumino, 79, 171
- age of the Universe, 11–12
- axion perturbations
 - canonical variable and pump field, 390–391, 400
 - present low-frequency spectrum, 417, 421–422
 - primordial isocurvature spectrum, 391–392, 400
- Bardeen potentials, 343
- Bianchi identity, 42, 58
- BKL oscillations, 154
- Bogoliubov transformation, 277–281
- brane–antibrane inflation,
 - attractive potential and effective action, 535–537
 - slow-roll parameters, 538, 542–543
 - toroidal transverse dimensions, 538–539
 - warped transverse dimensions, 539–543
- brane-gas cosmology, 236–238
- brane-world cosmology
 - assisted inflation on the brane, 516–518
 - dark radiation, 510
 - phenomenological constraints, 512–513
 - projected cosmological equations, 509–512
- brane-world scenario
 - domain wall approach, 487–490
 - Gauss–Codacci projection, 491–494
 - projected gravitational equations, 494–496
- Brans–Dicke model, 39, 42, 441, 442
- Chan–Paton factors, 121–122
- Christoffel connection
 - Bianchi-I type background, 134, 199
 - definition, xiv
 - spatially flat background, 44
 - warped background, 489, 514
- closed bosonic string
 - boundary conditions, 93
 - energy spectrum, 102–103
 - massless level, 103
 - Virasoro constraints, 94–95, 102
- CMB anisotropy
 - adiabatic initial conditions, 377–379
 - angular power spectrum, 380–392
 - adiabatic, large scale, 382–383
 - adiabatic, small scale oscillations, 383–385
 - isocurvature, large scale, 385–386
 - isocurvature, small scale oscillations, 386–387
 - isocurvature initial conditions, 379–380
 - tensor contributions, 295, 298, 387–389, 531–532
- comoving
 - coordinates, 2–3
 - observer, 5
- conformal
 - anomalies, 76–78, 80–83
 - gauge, 75
 - invariance, 72, 75
- cosmological
 - constant, 8–9, 464
 - red-shift, 4–5, 373–374
- covariant derivative, xiv
- critical density, 9, 444–445, 463
- critical dimensions
 - bosonic strings, 101–102
 - superstrings, 114–115
- curvaton mechanism
 - adiabatic initial conditions, 402–403
 - massive axion background, 394–396
 - non-Gaussian contributions, 401–402
 - normalization of the Bardeen spectrum, 403–407
- curvature perturbations
 - from slow-roll inflation, 365–368
 - from pre-big bang inflation, 369
- dark energy
 - critical fraction, 10–11, 464, 471
 - equation of state, 10, 464, 471
 - large scale acceleration, 10, 474–476
 - phantom, 476

- dark matter, 9–10, 463
- D-branes
 DBI action, 236, 535
 Dirichlet boundary conditions, 93
 interactions, 534–535
 wrapping modes, 236
- decoupling
 scale, 253
 temperature, 373
- differential forms
 curvature, 58
 external derivative, 57, 65
 external product, 64–65
 Hodge dual, 66
 Lorentz connection, 56–57
 torsion, 58
 vielbein 56
- dilatino, 119–120, 123
- dilaton
 charge density, 41, 143, 148, 438–439
 coupling, 439–443, 458, 460, 477
 mass, 437, 444–445, 457, 460, 476–477
 non-local potential, 174–175
 non-perturbative potential, 88–90, 473
 perturbative potential, 88
 sigma model action, 78–80
 stabilization, 89–90, 225–226
 tree-level action, 38–39
 tree-level equation, 41
- dilaton dark energy
 baryon-to-dark-matter ratio, 474
 coupling to dark matter, 466–468, 472
 dragging regime, 468–469
 freezing regime, 469–472
- Dirichlet branes, *see* D-branes
- Dvali–Gabadadze–Porrati (DGP) model, *see* induced gravity on the brane
- Einstein
 action, 39, 200
 equations, 2, 7–8
 tensor, 2, 40, 514
- Einstein frame
 equations, 48–49, 336–337
 solutions, 156–157, 183, 186
 transformations, 46–48, 50–52, 200, 467
- ekpyrotic
 cyclic model, 528–532
 scenario, 523–527
- electromagnetic perturbations
 canonical variable and pump field, 409
 pre-big bang amplification, 410, 412
 seeds for cosmic magnetic fields, 412–415
 superstring coupling to the dilaton
- equality
 curvature, 18, 294
 temperature, 17, 472
 time, 9, 37
- entropy production, 305–307
- Euler characteristic, 85
- Euler–Gauss–Bonnet invariant, 55, 63, 67, 217, 323
- exact solutions
 anisotropic with antisymmetric tensor, 166–167
 anisotropic with fluid sources, 148–152
 asymptotic limits, 153–155
- expansion
 α' , 37, 84–85, 210–213, 214, 222, *see also under* first-order α' corrections
 higher-curvature, *see* α'
 higher-derivative, *see* α'
 higher genus, *see* quantum loop
 multipole, 438–439
 quantum loop, 37, 85–89, 210–213, 228, *see also under* strong coupling corrections
- first-order α' corrections
 action, 52–55, 216–218, 227
 equations of motion, 60–63, 218
 field-redefinitions, 53–55, 221
 tensor perturbation equation, 326–329
- fixed points, 215, 219, 223
- gauge
 comoving, 344, 358, 359–361
 conformal, 4, 75
 light-cone, 93, 99–100, 107
 longitudinal, 343
 superconformal, 106
 synchronous, 3, 134, 256, 343
 uniform-curvature, 344
 uniform-density, 346
 uniform-dilaton, 344, 352
- Gauss theorem, 40
- geodesic
 completeness, 224
 convergence, 24
 coupling, 446, 457, 461, 479–480
 deviation, 445–447
 equation, 3
 null, 4, 5, 374, 375
 observer, 3
- Gibbons–Hawking boundary term, 41, 487–488
- graceful exit, 224–225, 526
- gravitational antennas
 cross-correlated response, 318–321
 noise power spectrum, 312–315
 optimal filtering, 320–321, 455
 overlap reduction function, 319, 454
 pattern function, 316–317
 response tensor, 317
 signal-to-noise ratio (SNR), 320–321
- gravitino, *see* Rarita–Swinger field
- horizon
 event, 5–6, 202–204
 particle, 5–6
- Hubble
 horizon, 202–204, 207
 parameter, xv
 radius, 2, 202–204

induced gravity on the brane, 519–522
 inflation
 chaotic, 30
 de Sitter, 25–26, 31–32, 195
 e-fold parameter, 29, 367, 368
 minimal duration, 23–24
 power-law, 29, 195
 slow-roll, 26–30, 366–368
 super-inflation, 196
 interferometric detectors
 common mode, 449, 480–481
 differential mode, 449, 457–459
 enhanced response of the common mode, 480–481
 overlap of common and differential modes, 478–480
 pattern functions for scalar–tensor radiation, 459–452
 response to a non-relativistic scalar background, 456–459
 SNR for scalar radiation, 454–456
 Israel junction conditions, 490, 493
 Kalb–Ramond axion, 43, 390
 Kaluza–Klein scenario, 484–485
 Kasner solution, 142
 level-matching condition, 102, 113–114, 126, 133
 local Lorentz symmetry, 56
 luminosity distance, 12–14, 463
 Majorana spinor, 105–106, 116, 124, 129
 metric
 Bianchi-I type, 134, 199, 214
 conformally flat, 4
 de Sitter, 25–26, 31–32
 homogeneous Bianchi models, 152–153, 171–173
 Milne, 168
 Robertson–Walker, 3–6
 warped geometry, 498, 514
 world-sheet, 74–75
 M-theory, 129, 210, 213, 429, 523
 Neveu–Schwarz
 boundary conditions, 108–111
 two-form, 42–44, 157, 171, 390
 non-Abelian duality, 171–173
 non-geodesic coupling, 446, 457, 480
 non-local
 action, 174
 general covariant equations, 175–177
 duality-invariant equations, 178–180
 normal modes, 254
 nucleosynthesis, 299, 304, 308
 numerical solutions
 background with α' corrections, 220, 223
 background with α' and loop corrections, 230
 perturbations with α' corrections, 329
 background with coupled dark energy, 472–474
 O(d,d) symmetry
 with sources, 161–165
 without sources, 157–160

open bosonic string
 Dirichlet and Neuman boundary conditions, 95
 energy spectrum, 100–101
 massless level, 101
 Virasoro constraints, 96
 perfect fluid
 barotropic, 7
 entropy density, 16, 18
 mixture, 8, 355
 stress tensor, 7, 134
 thermal equilibrium, 14–16
 Planck
 epoch, 20, 207–208
 length, mass, xiv–xv, 204–207
 pre-big bang
 inflation, 196, 202, 207–208
 minimal models, 299–301, 410
 scenario, 138–140, 146–148
 problem
 cosmic coincidence, 464, 474
 cosmological constant, 464
 flatness, 20–21
 horizon, 21–22, 204, 206
 landscape, 543
 missing mass, 463
 trans-Planckian, 34, 206–207
 pulsars, 298
 quintessence, *see* dark energy
 Ramond boundary conditions, 108–111
 Randall–Sundrum (RS) model, *see* warped geometry
 Rarita–Schwinger field, 104, 106, 119–120, 123, 128, 129
 regular exact solutions
 anisotropic with fluid sources, 181–182
 isotropic with non-local potential, 182–184
 isotropic with non-local potential and fluid sources, 185–188
 anisotropic with non-local potential and fluid sources, 190–191
 via-duality transformations, 168–171
 relic dilatons
 non-relativistic spectrum, 432–436
 phenomenological bounds, 444–445
 relativistic spectrum, 430–431
 relic gravitational waves
 from an ekpyrotic phase, 309–310
 from inflation, 287–289, 293–294
 from pre-big bang inflation, 301–303, 305
 phenomenological upper limits, 295–299
 stochastic average, 311–312, 318
 Sachs–Wolfe effect
 integrated, 376
 scalar perturbations, 373–376
 tensor perturbations, 376
 scalar perturbations
 canonical variable and evolution equations, 347
 entropy perturbations, 355–356
 frame transformations, 361–362

- gauge-invariant variables, 343–344, 346
- linearized equations of motion, 348–350
- local infinitesimal transformations, 340–342
- perfect fluid source, 356–359
- perturbed connection, 345
- perturbed Einstein tensor, 349
- perturbed metric, 337–339
- perturbed Ricci tensor, 348–349
- perturbed scalar and fluid sources, 339–340, 348
- perturbed scalar curvature, 345–346
- primordial spectrum, 363–365
- pump field, 347
- scalar field source, 351–354
- spectral index, 366
- super-horizon Bardeen spectrum, 368–369, 370–372
- scale-factor duality
 - higher-order extension, 221
 - with sources, 142–144
 - without sources, 136–138
- seed mechanism
 - induced Bardeen spectrum, 418–420, 423
 - quadratic sources of metric perturbations, 417–418
- self-duality, 139, 146–148, 182, 186, 189, 204, 222
- shifted
 - dilaton, 136–137, 140, 158, 174
 - variables, 143, 161, 179
- singularity
 - big bang, 19
 - big rip, 11, 198, 476
 - curvature, 224
 - initial, 30–34
 - sudden, 11
- spherical resonant detector
 - monopole mode, 460
 - pattern and overlap functions, 460–461
 - enhanced response, 461–463
- squeezed state, 280–281
- squeezing operator, 279–280
- strain density
 - tensor perturbations, 310–312
 - dilaton perturbations, 453–454
- string
 - α' parameter, *see* length
 - coupling, 37, 85–87, 142, 147–148, 210–213
 - equations of motion and constraints, 74, 92–93, *see also under* closed bosonic string and open bosonic string
 - length, xiv–xv, 37, 39
 - mass, xiv–xv, 39, 303–304, 307
 - perturbative vacuum, 147–148, 244, 246, 248
- string frame
 - action, 38, 45, 199
 - equations, 43
- string-gas cosmology, 233–235
- strong coupling corrections
 - action, 228–229, 440
 - equations of motion, 229
 - saturation, 90, 225, 465–466
- sudden approximation, 282, 285
- supergravity, 129
- superstrings
 - closed spectrum, 113–115
 - GSO projection, 116–117
 - heterotic model, 124–128
 - open spectrum, 113
 - super-Virasoro constraints, 107–108, 110–111
 - type IIA and type IIB models, 117–120
 - type I model, 121–124
 - world-sheet supersymmetry, 104–106
- tachyon, 101, 102, 115, 539
- target space duality, 132–134, 231
- T-duality, *see under* target space duality
- tensor
 - energy-momentum, 2, 40
 - extrinsic curvature, 488
 - Ricci, xiv, 7, 44, 135, 498
 - Riemann, xiv
 - Lanczos, 63, 69
 - Weyl, 493–494
- tensor perturbations
 - canonical normalization, 264–266
 - canonical variable and evolution equations, 263
 - conjugate momentum, 266
 - frame-independence, 261–262
 - graviton production, 281, 283–287
 - linearized equations of motion, 260
 - parametric amplification, 269–270
 - perturbed action, 259
 - perturbed action with α' corrections, 326
 - perturbed connection, 257, 258
 - perturbed Gauss–Bonnet invariant, 324–326
 - perturbed metric, 255–256
 - perturbed Ricci tensor, 257, 258
 - polarization, 262–263
 - power spectrum, *see* spectral amplitude
 - pump field, 263
 - spectral amplitude, 271–273
 - spectral energy density, 276
 - spectral index, 274–275
 - super-horizon expansion, 268–269
- third quantization, 247
- tidal stress tensor, 447–448
- time
 - conformal, 4, 155–156, 197, 260, 336, 374
 - cosmic, 3, 194, 201, 260
 - reversal, 136, 138
- vector–spinor, *see* Rarita–Swinger field
- viscosity coefficient, 166
- warped geometry
 - de Sitter brane in AdS bulk, 514–515
 - localization of gravity on the brane, 502–505
 - Minkowski brane in AdS bulk, 497–499
 - short-range gravitational corrections, 506–508

552

Weyl invariance, *see* conformal invariance
Wheeler–De Witt (WDW) equation
 differential representation, 240–241
 duality and operator ordering, 245–246
 scattering processes in minisuperspace, 247–248
Wheeler–De Witt (WDW) wave function
 antitunneling solutions, 248–249

Index

 free solutions, 241–242
 tunneling solutions, 243–244
winding
 number, 132–133
 modes, 213, 232–233, 234–235
 Z_2 symmetry, 490, 494