

Index

- A, A_N (analysing power), 119, 189, 420, 424
 a_e, a_f (electroweak couplings), 236
 A_{FB} (forward–backward asymmetry), 245
 A_{ij} (two-spin analysing power), 119, 466–9
 $e^- e^+ \rightarrow f\bar{f}$, 243
 $pp \rightarrow pp$, 420–3
 A_L, A_Z (longitudinal analysing power), 243
 \hat{a}_{LL} (parton asymmetry), 355–6
 A_{LR} (left–right asymmetry), 244
 measurement at SLD, 246, 257
 \hat{a}_{TT} (parton asymmetry), 377–8
 $\alpha_s(Q^2)$ (QCD effective coupling), 261
acceleration of polarized particles, 143–54
 Siberian snake, 151–4
Adair frame, 218
alignment, 53
analysing power, generalized, 186
anomalous magnetic moment, 109
anti-linear operators, 29
Argonne
 spin convention, 117
 reaction parameters, 118, 461–2
 shorthand notation, 463–4
asymmetries, *see* spin asymmetries
atomic beam, polarized 130–3
axial anomaly, 322
- Basel convention, 60
Bjorken limit (DIS), 304
 scaling, 299, 304
 sum rule, 323
BMT equation, 146
Brodsky–Lepage
 helicity rule, 425
 mechanism, 424
- canonical rest frame, 13
 spin state, 12
charge conjugation, 30
 for fields, 35
charged current interactions, 235
chirality 89
- helicity, relation to, 90
collinear singularities, 326
Collins mechanism, 391
colour in QCD, 285, 292–6
Compton scattering, 198
constituent quarks, 298
Coulomb interference, 187, 420–3
covariant derivative in QCD, 260
covariant spin vector, *see* spin vectors
crossing relations, 80, 415
 massive particles, 80–2
 massless particles, 82
 C_A (QCD), xvii
 C_F (QCD), xviii
 $C_2(G)$ in QCD, xvii
 $C_2(R)$ in QCD, xviii
 C_{ij} (final state correlation parameters in e^-e^+), 246
- D (in hyperon decay) 322
 D_{ij} (depolarization parameters) 465–8
 e^-e^+ , 246
- \hat{d}_{NN} (parton spin transfer) 393
 $d_{\mu\nu}^j(\theta)$ (rotation functions) 433–6
- $\Delta G(x)$ (polarized gluon density) 325
 behaviour at $x = 0, 1$, 336
 phenomenology, 331–5
- $\Delta q(x)$ (polarized quark density) 307
 behaviour at $x = 0, 1$, 336
 evolution of, 327
 parametrization of, 332
 phenomenology, 331–5
- $\Delta_T q(x)$ (transverse polarized quark density), 342
 evolution of, 343–4
 Soffer bound for, 343
- $\Delta\sigma_L$ (longitudinal polarization cross-section difference) 94
 phenomenology in $pp \rightarrow pp$ 419
- $\Delta\sigma_T$ (transverse polarization cross-section difference) 94
 phenomenology in $pp \rightarrow pp$ 418
- $\Delta\Sigma(x)$ (polarized quark singlet density) 323

- decay parameters, table of, 220
 deep inelastic scattering (DIS), 298–347
 neutral current phenomenology, 331–5
 neutrino beams, 344–7
 cross-section formulae, 346
 see also, parton model
 density matrix, 38
 alignment, 53
 degree of polarization, 51
 diagonalization, 48
 final state particles, 63, 98
 behaviour at $\theta = 0, \pi$, 99
 rank conditions, 99
 resonance production, 65
 secondary scattering, 65
 general properties 40
 helicity multipole parameters 58
 initial state particle, 61
 mixed systems, 42
 multipole parameters, 44
 non-relativistic, 39
 photons, 54
 polarization vectors, 53
 positivity, 56
 quantization axis, 48
 relativistic, 57
 spherical tensors, 44
 spin-1 particles, 51
 tensor polarization, 52
 Dicus relation in DIS, 347
 dimensional counting rules, 430
 diquarks, 431–2
 Dirac form factors, 85
 spinors, 476–84
 Dirac–Pauli representation, 480
 massless fermions, 481–3
 Weyl representation, 481
 distribution amplitudes, 425
 double scattering, 205
 dual Ward identity, 296
 dynamical reaction parameters, 101, 465–72
 Argonne spin conventions, 117, 461–2
 cartesian formalism for spin-1/2, 115–20,
 459–462
 ϕ -dependence of cross-section, 119
 experimental determination, 104
 helicity amplitudes, relation to, 465–72
 inclusive and multiparticle reactions, 125–8
 non-linear relations, 123
 polarized beam, 107
 final states, properties of, 110–12
 initial multipole parameters, 108
 magnetic field, use of, 108
 polarization transfer, 110
 polarized target, 112
 polarized target and beam, 112–3
 photon-induced reactions, 123
 spin 1/2 spin 1/2 \rightarrow arbitrary spin, 120
 spin 1/2 + spin 1/2 \rightarrow spin 1/2 + spin 1/2,
 119
 properties, 102–4, 459–62
 unpolarized initial state, 105
 see also Argonne reaction parameters,
 laboratory reaction parameters
 e^\pm colliders, *see* polarized e^\pm beams
 e^\pm reactions, *see* electroweak interactions
 elastic scattering, 413–32
 large momentum transfer, at, 423–32
 angular momentum, role of, 431–2
 Brodsky–Lepage helicity rule, 425
 Brodsky–Lepage mechanism, 423
 dimensional counting rules, 430
 diquarks, 431
 distribution amplitude, 425
 Landshoff mechanism, 424
 Sudakov suppression, 430
 small momentum transfer $pp \rightarrow pp$, 414–20
 $\Delta\sigma_L, \Delta\sigma_T$, 419–20
 electromagnetic interference, 187, 420–3
 exchange contributions, 415
 electromagnetic–hadronic interference, 187,
 420–3
 electroweak interactions, 234–57
 charged current, 235
 Feynman vertices, 235–9
 Kobayashi–Maskawa matrix 238
 lagrangians, 235–9
 neutral current, 236
 precision tests, 239–51
 propagators, 235–9
 Weinberg angle, 235
 $e^-e^+ \rightarrow$ fermion–antifermion pair, 241
 analysing power, longitudinal, 243
 correlations, initial state, 243
 correlations, final state, 246
 cross-section with polarization, 244
 depolarization, 246
 forward–backward asymmetry A_{FB} , 245
 forward–backward asymmetry for heavy
 quarks, 256
 left–right asymmetry A_{LR} , 244
 polarization, final state, 246–7
 polarization, initial state, 254
 polarization transfer, 246
 $q\bar{q}$ production, 255–7
 $q\bar{q}$ heavy quarks, 256
 τ polarization, 247–53
 $\tau^+\tau^-$ correlations, 253–4
 Efremov, Leader and Teryaev (ELT) sum rule,
 320
 F (in hyperon β -decay) 322
 Φ (quark density matrix) 313
 factorization (Regge poles), 418
 Feynman rules for massless particles, 264–96
 Compton scattering, high energy, 279
 gluon Compton scattering, 281
 helicity theorem, 268–70
 massive spinors, 273–4
 massless spinors, 265
 multigluon amplitudes, 284

- multigluon colour structure, 285
 multigluon colour sums, 292–6
 multigluon dual Ward identity, 296
 multigluon helicity structure, 286–7
 multigluon $G + G \rightarrow G + G$, 282–92, 294–6
 polarization vectors, 274–8
 gauge freedom, 275–8
 spinor product, 265
 shorthand notation, 278
 $e\mu \rightarrow e\mu$, high energy, 272–3
 fermionic pole (semi-inclusive DIS) **404**
 Feynman rules for QCD, 264–96, **473–5**
 fields, irreducible, 444–9
 equations of motion, 447–9
 Dirac equation, 449
 parity, 447
 fields, usual, 30–7
 discrete symmetries, 34–7
 Lorentz transformations, 30–3
 Fierz rearrangement theorem, 483
 form factors, Dirac
 pion, large momentum transfer, 427–30
 proton, 85
 Sudakov suppression, 429
 forward–backward asymmetry A_{FB} , 245
 Froissart–Martin bound, 415
 frozen polarized targets, 133–7
- $g_1(x)$ (DIS) 300
 behaviour at $x = 0, 1$, 336–9
 cross-section, in terms of 304
 phenomenology, 331–5
 Regge behaviour, 337
 $g_2(x)$ (DIS) 300
 cross-section, in terms of, 304
 $G_{1,2}$ (DIS form factors) 303
 gallium–arsenide source, 182
 gamma matrices, **476**
 Dirac–Pauli representation, 480
 Fierz rearrangement theorem, 483
 traces, 476–7
 Weyl representation, 481
 gas-jet targets, 137–43
 gauge invariance
 in QCD, 262–4
 in QED, 262
 Gell–Mann matrices, 260
 gluon
 anomaly (DIS) 324
 number density (DIS) 325
 phenomenology, 331–5
 orbital angular momentum, 326
 spin (DIS) 326
 gluonic pole (semi-inclusive DIS) **404**
- harmonic spin matching, 175
 helicity, 7
 chirality, relation to, 89
 helicity amplitudes, **73**
 analytic properties, 79
 behaviour at $\theta = 0, \pi$ 79
- charge conjugation, 79
 crossing, 80–2
 massless particles, 82
 $pp \rightarrow pp$, 415
 identical particles 76
 Landau–Yang theorem, generalization 78
 notation in reactions, 453–4
 parity, 75
 $pp \rightarrow pp$, 415
 phase at high energy, 417
 time reversal, 76
 $E \rightarrow C + D$, 78
 $pp \rightarrow pp$, 77, 414–20
- helicity rest frame, 13
 density matrix, 57
 Lorentz transformations, 59
 multipole parameters, 58
 Lorentz transformations, 59
 helicity selection rules, 80–8
 axial-vector currents, 88
 high energy limit, 80
 particle–antiparticle creation, 88
 vector currents, 88
 helicity states, **7–17**
 Lorentz transformations, 18–30
 helicity theorem, 268–70
- identical particles, 76
 imperfection resonances, 150
 inclusive reactions, 208, 298–344
 infinite momentum frame, **305**
 intrinsic resonances, 150
 isospin, **36**
 antiparticles, 36
- Jacobi identity, 263
 JET scheme (DIS), 329
- K_{ij} (polarization transfer parameters) **467–8**
 $e^-e^+ \rightarrow f\bar{f}$, 246
 Kobayashi–Maskawa matrix, 238
- laboratory (Lab) frame, **xviii**
 laboratory reaction parameters, 113–5, 461–2
 Landau–Yang theorem, generalization, 78
 Landshoff mechanism, 424
 leading logarithmic approximation (LLA), 327
 left–right asymmetry A_{LR} , 244
 SLD measurement of, 246, 257
 longitudinal polarization state, **342**
 longitudinal polarized parton density, *see* $\Delta q(x)$, $\Delta G(x)$
 Lorentz transformations **10**, 18–30, 437–443
 density matrix, 59
 fields, **30**
 finite-dimensional representations, 437–9
 generators 437
 helicity multipole parameters, 59
 helicity states, 18–30
 massive particles, 18
 massless particles, 24

- spinor representation, 439–42
 vector representation, 442–3
 Lund model for asymmetries, 409
- magnetic moment, 24, 109
 anomalous, 109
 of Ω , 160
- Mandelstam variables, 351
- mass singularities, 326
- matrix elements
 vector current, 82
 axial and vector coupling 85
- Møller scattering, 196
- moments (DIS), 319
- multipole parameters, *see* density matrix
 rotations, effect on 48
- $\overline{\text{MS}}$ scheme (DIS) 328
- $\overline{\text{MS}}\text{-MNV}$ scheme (DIS) 329
- neutral current interactions, 236
- neutrino beams, 344
- observables **92**, 101
 non-linear relations amongst, 123
see also dynamical reaction parameters,
 laboratory reaction parameters
- odderon, 416
- operator product expansion (OPE), 308
 moments, 320
 Bjorken sum rule, 323
- optical theorem, **92**
 arbitrary spin particles, 95
 deuteron–deuteron scattering, 97
 deuteron–nucleon scattering, 96
 generalized, 93
 nucleon–nucleon scattering, 94
- orbital angular momentum of gluons, 326
- Ω particle, magnetic moment of, 160
- parity transformation, **27**
 fields, 34
 helicity amplitudes, 75
- partons 259, 298
 parton model for charged current DIS, 346–7
 Dicus relation, 347
- parton model for neutral current DIS, 300, **305**
field theoretic generalization, 308–18, 339–43
 quark density matrix Φ , **313**, 340–2
 structure function g_1 , 316–7, 327
 structure function g_2 , 318–9
 $g_1(x)$, 307
 $g_2(x)$, 308
 inclusive reactions, 349
 JET scheme, 329
 $\overline{\text{MS}}$ scheme, 328
 $\overline{\text{MS}}\text{-MNV}$ scheme, 329
 polarized parton densities, 307
 parametrization, 332
- QCD corrections, **326**
 evolution, 326
- leading order, 327
 next-to-leading order, 327–31
 scheme dependence, 327–31
 scheme transformations, 330–1
 semi-inclusive reactions, 348–75
 spin crisis, 301
 transverse polarized quark densities, **342**
 evolution, 343–4
 Soffer bound, 343
- unpolarized parton densities, 307
- partonic reactions, 354
 cross-sections, 354
 longitudinal double spin asymmetry \hat{a}_{LL} ,
 355–6
 transverse double spin asymmetry \hat{a}_{TT} , 377–8
- Pauli–Lubanski operator, **8**, 67
- phase of amplitude, 417
 $\pi \rightarrow \mu\nu$, 202
- polarimetry with stable particles, 186–209
 Compton scattering, 198
 Coulomb interference, 187, 420–3
- double scattering 205
 $AB \rightarrow \gamma D$, then $\gamma D \rightarrow AB$, 207
 $pp \rightarrow pp$, then $pp \rightarrow pp$, 206
- inclusive asymmetries, 208
 $pp \rightarrow \pi X$, 208
- Møller scattering, 196
- Primakoff reactions, 191
- polarimetry with unstable particles *see*
 resonance decay to two particles, resonance
 decay to three particles
- polarization (spin-polarization vector) **44**
 circular, 54
 degree of, 50
 even and odd, **47**, 107
 linear, 55
 tensor, 52
 $pp \rightarrow pp$, 426
- polarization correlations 105, 253
- polarization vector, **53**
 field theory, 70
see also spin-polarization vector
- polarization transfer, 110
 depolarization, 110
- polarized e^\pm beams, **165**
 perfect circular ring, 165–73
 Sokolov–Ternov effect, 166
- imperfect ring, 173–6
 harmonic spin matching, 175
- HERA, 179–81
- LEP, 176–9
- linear collider SLC, 181–4
 gallium arsenide source, 182
- polarized hadron beams, 158–64
 at Fermilab, 161
- polarized hadrons, production, **129**
- polarized particles, acceleration, **143**
 difficulties, 147
 imperfection resonances, 150
 intrinsic resonances, 150
 Siberian snake, 151–8

- Stern–Gerlach polarizer, 154–8
 polarized parton densities, *see* $\Delta q(x)$, $\Delta_T q(x)$,
 $\Delta G(x)$
 polarized states analysis, *see* polarimetry
 polarized targets, 130
 atomic beam, 130–3
 frozen, 133–7
 gas-jets, 137–43
 HERMES cell, 139
 Mark-II, 138
 SLAC helium-3, 141
 polarizing power 105
 pomeron, 416
 Primakoff reactions, 191
 pseudo-thresholds, 80, 452
- $q(x)$ (parton density), *see* $\Delta q(x)$, $\Delta_T q(x)$
 quantization axis, 48
 quantization plane, 108
 quantum chromodynamics (QCD), 256
 covariant derivative, 260
 effective coupling $\alpha_s(Q^2)$, 261
 gauge invariance, 262–4
 gluon field, 259
 Jacobi identity, 263
 quark field, 260
 quark masses, 260
see also Feynman rules
- rank of matrix, 99
 rank- L polarization, 51, 95
 rapidity, 351
 reactions, decays, general $E \rightarrow C + D$, 78
 fermionic, spin J ($J \geq 3/2$) \rightarrow spin $J_1 +$ spin 0 ,
 218
 $a_2 \rightarrow \rho\pi$, 216
 $D \rightarrow K\pi$, 216
 $D^{*+} \rightarrow \gamma D$, 216
 $\Delta \rightarrow N\pi$, 216
 $f \rightarrow \pi\pi$, 216
 $\Lambda \rightarrow N\pi$, 217
 $\Lambda_c \rightarrow \Lambda\pi$, 220
 $\Lambda_c \rightarrow \Sigma\pi$, 210
 $\omega \rightarrow \gamma\pi$, 216
 $\omega(1670) \rightarrow \rho\pi$, 216
 $\pi \rightarrow \mu\nu$, 202
 $\psi \rightarrow \rho\pi$, 216
 $\rho \rightarrow \mu^+\mu^-$, 211
 $\rho \rightarrow \pi\pi$, 216
 $\Sigma \rightarrow p\pi$, 220
 $\tau \rightarrow v\pi$, 216
 $\tau \rightarrow a_1 v$, 248
 followed by $a_1 \rightarrow 3\pi$, 252
 $\tau \rightarrow \rho v$, 248
 followed by $\rho \rightarrow \pi\pi$, 250
 $\Xi \rightarrow \Lambda\pi$, 220
- reactions, scattering, by name
 Compton scattering, 279
 Drell–Yan reactions, 358
 $J/\psi, \xi_2$ production, 362
 gluon Compton scattering, 281
- inclusive reactions, 125–8
 Mueller discontinuity formula, 129
 photon-induced, 123, 469–71
 reactions, scattering, by symbol
 $\text{spin } 1/2 + \text{spin } 1/2 \rightarrow \text{spin } 1/2 + \text{spin } 1/2$,
 119, 414–27, 466–71
 $\text{spin } 1/2 + \text{spin } 1/2 \rightarrow \text{spin } 0 + \text{spin } 0$ 120, 466
 $\text{spin } 1/2 + \text{spin } 1/2 \rightarrow \text{arbitrary spin}$, 120
 $\text{spin } 0 + \text{spin } 1/2 \rightarrow \text{spin } 0 + \text{spin } 1/2$, 120, 465
 $0^- + 1/2^+ \rightarrow 0^- + 3/2^+$, 472
 $0^- + 1/2^+ \rightarrow 1^- + 1/2^+$, 472
 $AB \rightarrow \gamma D$, 207
 $d + d \rightarrow d + d$, 97
 $d + n \rightarrow d + n$, 96
 $e^- e^+ \rightarrow f\bar{f}$, *see* electroweak interactions
 $e^- e^+ \rightarrow \tau^-\tau^+$, 253–4
 $e\mu \rightarrow e\mu$, 272–3
 $G + G \rightarrow G + G$, 288–92, 294–7
 $l + N \rightarrow l + X$, 299
 $l + N \rightarrow v + X$, 302
 $l + p \rightarrow l + c\bar{c} + X$, 365
 $pp \rightarrow pp$, 77, 206, 414–27, 466–71
 $pp \rightarrow \gamma X$, 357, 406–9
 $pp \rightarrow \pi X$, 355
 $p\bar{p} \rightarrow \pi\pi$, 466
 $\pi N \rightarrow \pi N$, 465
 $\pi^- p \rightarrow \pi^0 n$, 417
- Regge behaviour (DIS), 337
 Regge poles in $pp \rightarrow pp$, 415–20
 factorization, 418
 residue functions, 418
 reference frames, choice of, 60
 laboratory analysing frames, 66
see also rest frames
- renormalization scheme dependence, 321
 $\overline{\text{MS}}$, 328
 $\overline{\text{MS}}\text{-MNV}$, 329
 JET, 329
 transformations between, 330–1
 residue function (Regge pole), 418
 resonance decay amplitudes, 78
 charge conjugation, 79
 identical particles, 78
 Landau–Yang theorem, generalization, 78
 resonance decay parameters, 219
 table of, 220
 resonance decay into two particles, 209–23
 angular distribution, 210
 bosonic decay chains, 220
 decay parameters, 217
 table of, 220
 $e^- e^+ \rightarrow \Lambda X$, 219
 fermionic decay chains, 220
 fermionic spin $J \geq 3/2 \rightarrow$ spin $J_1 +$ spin 0 , 218
 magic decays, 216
 moments of distributions, 214
 multipole parameters for final state, 211
 parity violating decays, 216
 spin $J \rightarrow$ spin $1/2 +$ spin 0 , 216
 W decay, 222–3

- $\rho \rightarrow \mu\mu$, 221
see also τ decay
- resonance decay into three particles, 223–33
 decay amplitudes, 223
 decay into spinless particles, 227–9
 decay into γ and two spinless particles, 232
 decay to spin-1/2 particle and two spinless particles, 229–32
 moments of distributions, 227
 normal to the decay plane, distribution 225
 identical particles, 226
 parity, 225
- resonant depolarization, 176
- rest frame
 helicity, 13
 canonical, 15
- rotation functions $d_{\lambda\mu}^j$, 433–6
- rotation group, 433–6
- rotations, transformation under, 5
 density matrix, 47
 operators, 433
 representation matrices 433–6
- running coupling (QCD), 261
- scaling functions (DIS), *see* structure functions
- scattering amplitude, *see* helicity amplitudes
- signature (τ), 415
- Sivers mechanism, 390
- Soffer bound, 343, 378, 398
- Sokolov–Ternov effect, 166
- spherical tensors, 44
- spin asymmetries, general theory, 185–233
 Compton scattering, 198
 double scattering, 205
 elastic scattering, 418–26
 $pp \rightarrow pp$, 418–9, 426
 electromagnetic-hadronic interference, 187, 420–3
 inclusive reactions, 208, 349
 Møller scattering, 196
 Primakoff reactions, 191
 resonance decay into two particles, 209–23
 resonance decay into three particles, 223–33
 $AB \rightarrow CD$ 186
 A_{FB} (forward–backward), 245
 A_{LR} (left–right), 244
 $e^-e^+ \rightarrow f\bar{f}$, 241–57
 $e^-e^+ \rightarrow q\bar{q}$, 255
 $\mu \rightarrow e\nu\bar{\nu}$, 202
 $\tau^- \rightarrow \pi^- + v_\tau$, 248
 $\tau^- \rightarrow V + v_\tau$, 248
 $\tau^-\tau^+$ correlations, 253
see also reactions, spin asymmetries,
 semi-inclusive reactions
- spin asymmetries, semi-inclusive reactions, 349–412
 longitudinal two-spin, 352–68
 Drell–Yan, 358
 Drell–Yan production of J/ψ and χ_2 , 362
 $l + N \rightarrow l + X$, 298–344
- $l + p \rightarrow l + c\bar{c} + X$, 365
 $pp \rightarrow \gamma X$, 357
 $pp \rightarrow \pi X$, 355
- parity-violating longitudinal single-spin, 368–75
 W and Z production, 369–75
 transverse single-spin case, 382–412
 transverse phenomenological models, 408–412
 Lund model, 409–10
 Thomas precession model, 410–11
- soft physics mechanisms, 388–407
 Collins mechanism, 391–8
 fermionic poles, 404
 gluonic poles, 404
 Sivers mechanism, 390
 Soffer bound, 396
 qGq correlator mechanism, 398–407
 $pp \rightarrow \gamma X$, 406–7
- transverse theoretical problems, 384
- transverse two-spin, 375–81
 Soffer bound, 378
- spin correlations, 105, 252
- spin crisis (DIS), 319, 323
 gluon anomaly, 324
- spin matching, 175
- spin-polarization vector, 6
- spin splitter, 154–158
- spin states, helicity, 12
 canonical, 12
 zero mass, 15
- spin vector, covariant 67
 helicity states, 69
 massless particles, 69
 mean, motion of 144
 polarization vector, relation to 70
- spinors, 439–42, 478–83
 Dirac–Pauli representation, 480
 dotted and undotted, 439
 helicity, 478
 Lorentz transformation, 439–42
 massless fermions, 265, 481–3
 non-relativistic, 2
 spinor products, 265
 vector representation, connection to, 442–3
 Weyl representation, 273, 481
- splitting functions (QCD evolution), 327, 331
- statistical tensors, 46
- Stern–Gerlach experiment 1
- spin tensor, covariant, 69
 polarization vector, relation to 70
- storage rings for e^-e^+ , *see* polarized e^\pm beams
- structure functions, neutral current DIS, 302–43
 charged current DIS, 344–7
- Sudakov suppression, 429
- sum rules (DIS), 319
 Bjorken, 323
 Efremov, Leader, Teryaev (ELT), 320
- $T(R)$ (QCD), xvii
- τ -lepton polarization measurement, 247–53
 $\tau \rightarrow a_1 v$, 248

- followed by $a_1 \rightarrow 3\pi$, 252
- $\tau \rightarrow \pi\nu$, 248
- $\tau \rightarrow \rho\nu$, 248
 - followed by $\rho \rightarrow \pi\pi$, 250
- τ signature, 415
- $\tau^-\tau^+$ spin correlations, 253
- targets, *see* polarized targets
- tensor operators for spin 1, 52
 - relativistic, 69
- tensor polarization, 52
- Thomas precession, 2, 24, 146
 - BMT equation, 146
 - model for semi-inclusive asymmetries 410
- thresholds, 80, 452
- time-reversal transformation, 28
 - fields, 34
 - helicity amplitudes, 76
- transition amplitudes, *see* helicity amplitudes
- transverse polarization states, 342
- transverse-polarized quark density, 342
- transversity amplitudes, 450–2
- triangle anomaly, *see* axial anomaly
- twist, 320
- v_e, v_f (electroweak couplings), 236
- vector, axial-vector couplings, 85–8
- high energy limit, 88
- particle vs. antiparticle, 86
- particle–antiparticle creation, 88
- vertices, general, 85
- vector current, matrix elements, 82
- W decay, 222–3
- $W_{\mu\nu}$ (DIS)
 - neutral current, 303
 - charged current, 345
- wave equations, 444–9
 - Dirac, 449
- wave functions in fields, 30–7
- Weinberg angle, 235
 - value, 245
- Weyl representation, 273
- Wick helicity rotation, 19
- high energy, 24
 - Lorentz boost, 21
 - Lorentz transformation from CM to Lab, 22
 - massless particles, 24
 - non-relativistic limit, 23
 - rotations, 20
- Wigner rotation, 20