

Index

- Abelian group 227
- accelerators 18
- action 27, 30, 39
- α_s (Q^2) 159, 170
- Altarelli–Parisi equations 173, 242
- annihilation operator 78
- anomaly 215
- antiparticle 3
- asymptotic freedom 158
- axial coupling constant 179

- B mesons 147
 - decays of 180
 - and CP symmetry 182
- BaBar detector 18, 180
- baryon 4, 156
- Belle detector 180
- β decay 91
- Bjorken scaling 242
- Bohr magneton 75
- boost 21, 54, 58
 - on spinors 231
- boson 1
 - field quantisation 77–78
- bottomonium 11, 12, 162
- Breit–Wigner formula 133

- Callen–Gross relation 241
- CERN 18, 128, 148
- charge conjugation
 - electromagnetic field 44
 - spinor fields 71
 - W fields 123
 - Z field 123
- charmonium 11, 12, 162
- chiral representation
 - of Dirac matrices 50, 55
 - of γ -matrices 1
- chiral symmetry 164, 216
- Cleo 180
- colour 11
 - gauge fields 153
 - gauge transformation 156

- singlet 157
- triplet 153
- complex scalar field 36
- confinement 2, 4, 166
 - length 161
- conservation laws
 - Dirac particles 68
 - electric charge 38, 41, 123
 - energy 29, 35
 - lepton number 4, 95, 122, 126, 193, 218
 - momentum 35
 - quark number 162, 218
- contravariant four-vector 22
- covariant four-vector 22
- CP symmetry 123
- CP symmetry breaking 220
 - Dirac neutrinos 192, 205
 - direct 180
 - in B decays 182
 - in K decays 180
 - and the KM matrix 143
 - Majorana neutrinos 210
 - through mixing 182, 246, 247
- CPT theorem 183, 245
- creation operator 78

- deep inelastic scattering 171
- Δ baryon 6, 7
- dimensional transmutation 167
- Dirac equation 49
 - energy–momentum tensor of 63
 - in electromagnetic field 68
 - intrinsic spin and 59
 - Lorentz invariance of 51
 - magnetic moment and 74
 - negative energy solutions 62
 - plane wave solutions 64
 - space inversion of 54
 - two-component form of 52, 58
- double β decay 214

- $e^+ e^-$ colliding beams 11, 13, 130, 173

270

effective Lagrangian density
 for β decay 145
 for muon decay 96, 121
 for muon neutrino elastic scattering 98, 122
 for pion decay 93
 electron 1, 3
 magnetic moment of 75, 87
 Einstein principle of relativity 20
 Einstein summation convention 21
 energy–momentum tensor
 of Dirac field 63
 of electromagnetic field 45
 of scalar field 35
 Euler–Lagrange equations 28

 Fermilab 11, 18
 Fermion 1, 49
 field quantisation 77–79
 Feynman diagram 13, 84
 field strength tensor
 of electromagnetic field 39
 of gluon gauge field 154
 of massive gauge field 110
 Fierz transformation 225
 fine-structure constant 11, 81
 forward–backward asymmetry
 of leptons 136
 of quarks 149

 G_F 96, 97, 121
 g 154
 g_1 108, 112
 g_2 109, 112
 g' 118
 g_A 179
 γ -matrices 55
 γ^5 xv, 55
 gauge
 Lorentz 42
 radiation 41, 78
 gauge field 70, 105, 109, 153
 gauge transformation 40, 69, 156
 global transformation 67
 gluon 2, 244
 gauge field 154
 Goldstone boson 104
 gravitation 1, 20

 hadron 4, 169
 Hamburg 15, 18, 239
 Hamiltonian 30, 77
 Hamilton's principle 27
 Heisenberg picture 80
 helicity 61
 of neutrino 187
 HERA 239
 Higgs boson 18, 34, 105
 mass of 115
 Higgs field 111, 155
 coupling constants to 119, 191
 hole theory 63

Index

intrinsic spin of
 Dirac particle 59
 massive vector boson 47
 photon 44
 isospin symmetry 5, 8, 162, 163, 242

 Jarlskog factor 143
 jet 15, 17, 147, 244
 J/Ψ resonances 11

 K mesons
 and CP symmetry 180
 decays of 101, 145
 Klein–Gordon equation 33, 36, 50, 58, 73
 Kobayashi–Maskawa matrix 142, 151, 177
 and leptonic decays 176, 178, 179

 Lagrangian 27
 for particle in electromagnetic field 48
 Lagrangian density for
 charged scalar field 73
 Dirac field 51, 52, 55
 electromagnetic field 39
 flexible string 30
 gluon field 154
 massive vector field 46, 113
 Majorana field 207
 quark fields 141, 155
 scalar field 32
 Weinberg–Salam theory 120
 Λ 161
 Λ_{Latt} 166
 lattice QCD 158, 166
 and hadrons 171
 spacing 170
 left-handed
 lepton doublet 117, 232
 spinor field 54
 quark doublet 138
 LEP 130
 lepton 2, 3
 number conservation 4, 95, 122
 coupling to Higgs field 119
 coupling to W 120
 coupling to Z 121
 family 131, 217
 universality 93, 94, 120
 lepton number non conservation 212
 Levi–Civita tensor 24
 local field theory 32
 local gauge transformation 70
 Lorentz transformations 20
 group of proper 21, 231
 of spinors 54, 232

 magnetic moment
 of electron 75, 87
 Majorana fields 65, 206
 CP transformations 210
 Lagrangian density 207
 mixing and oscillations 209

- Majorana neutrinos 65
 - plain wave expansion 206
- massive vector field 46
 - see also W bosons, Z boson
- matter genesis 220
- meson 4, 157
 - B 147
 - K 10
 - π 5, 34, 93
 - strange 10
- metric tensor 22
- MSW effect 190, 203
- muon 3, 11, 93
 - decay 96
 - neutrino 96, 98
- neutral current 99, 122
- neutrino 3
 - atmospheric 200
 - coupling to Higgs field 191, 210
 - CP transformations 75
 - massless limit 65
 - mass matrix 186
 - mass squared differences 189, 194
 - mixing and mixing matrix 186, 192, 195, 210
 - oscillations 187, 189, 209
 - solar 200
- neutron 1, 4
- Noether's theorem 3, 29
 - currents 156
- parity 7, 8, 10, 42, 54, 59, 91
 - see also space inversion
- parton model 16, 238
- Pauli exclusion principle 49, 79
- Pauli spin matrices xv, 50, 108
 - transformations of 232
- perturbation theory 81
- photon 2, 44, 78
- polarization 42, 47
- proton 1, 4, 238
- quantum chromodynamics (QCD) 153
 - lattice 166
 - perturbative 171
- quantum electrodynamics (QED) 2, 69, 77
- quark 2
 - see also colour, confinement
 - bottom 4
 - charmed 4
 - constituent 244
 - diagram 8
 - doublet 138
 - down 4
 - families 138, 217
 - flavour 4, 10
 - mass 4, 139, 170
 - model 8
 - sea 169
 - strange 10
 - top 10, 18, 180
 - true 140
 - up 4
- quenched approximation 158
- R(E) 11
- renormalisation 77–78, 83, 87, 106, 114, 120, 159, 215, 217
- right-handed spinor field 54, 232
- rotation group 20
 - active 229
 - and intrinsic spin 45, 59
 - and SU(2) 229
 - matrix 228
 - passive 229
- scalar 22
 - field 23
- sea saw mechanism 211
- sea quarks 169
- second quantisation 49, 79
- σ^μ ; $\tilde{\sigma}^\mu$ 52, 232
- SLC 130, 149
- space inversion 25, 42, 54, 59
- spinor 24, 54
- spin–orbit coupling 75
- Stanford 16, 18, 130
- sterile neutrinos 193
- string tension 167
- strong interaction 2, 5, 153
 - coupling constant 154
 - effective coupling constant 158
- SU(2) symmetry 107, 117
 - group 229
- SU(3) symmetry 153
 - group 233
- symmetry
 - global 67
 - local 70
- symmetry breaking
 - isospin 163
 - local 104, 111
 - spontaneous 103
- tau lepton 3, 92
 - decays 95, 97
- τ matrices 163
- tensor 24, 234
 - pseudo- 26
 - see also energy–momentum tensor
- tevatron 18
- time reversal 25, 183
- topological number 218
- U 194, 195
- U_{ei} 188
- U(1) symmetry 67, 70, 104, 107, 117
- Units 18
- upsilon 11
- unitary sum rules 176

272

vacuum polarization 84, 158
vacuum state 78, 86, 111
 topological number 219
valence quarks 169

W boson 1, 113
 coupling to lepton fields 120
 coupling to other gauge bosons 113
 coupling to quark fields 141
 hadronic decays 150
 leptonic decays 129
 mass 114
weak currents
 charged 95, 186
 neutral 99, 187

Index

W^+ fields 110
W gauge fields 108
weak interaction 1, 91
weak isospin 109
Weinberg angle 112, 114, 122

Z boson 1, 113
 asymmetries 135, 149
 coupling to lepton fields 121
 coupling to other gauge bosons
 113
 coupling to quark fields 141
 hadronic decays 147
 leptonic decays 130
 mass 114