

# Index

- $\Delta_+$ -distributions, 39, 44  
 $K/\pi$ -ratio, 227  
 $S$ -operator, 33, 38  
 $\beta$ -function, 85, 407  
 $\delta$ -distribution, 39, 45, 50  
 $\eta'$ -puzzle, 261  
 $\kappa$ -method for analytic  $\lambda$ -calculations, 350, 363  
 $\lambda$ -measure, generalised rapidity, 270, 298, 347, 350, 384  
 $\rho$ -trajectory, 190, 347  
 $a$ ,  $a^*$ -operators, 29  
 $a$ -parameter in the Lund model, 151, 166, 178, 190, 239, 347  
 $b$ -parameter in the Lund model, 151, 178, 192, 196, 197, 199, 205, 347  
 $n$ -particle phase space, 62, 178, 181, 192  
  
Aharonov-Bohm effect, 202  
Amati-Fubini-Stanghellini (AFS) model, 183  
Anomalous dimensions of QCD, 270, 352, 391, 407, 410  
Antenna pattern, 314, 320  
Area interpretation of the decay formulas, 153, 158, 178, 192  
ARIADNE, Monte Carlo program for the DCM, 318, 320, 321, 325, 337, 339, 340, 346, 349, 356, 363, 381, 391, 424, 432, 433, 441  
Artru-Menessier-Bowler model, AMB, 159, 238, 322, 343  
Attractive fixed point, 88  
  
Baryon fragmentation, 423  
Baryon production, 234, 241, 298, 344  
BFKL mechanism, 401  
Bohr radius, 20, 98  
Bowler's area suppression, 236, 237  
Breit frame, 307  
Breit-Wigner form factor, 240, 259  
Brownian motion, 189, 213, 219, 389  
  
Callan-Symanzik equation, 85, 351, 365, 398, 400, 407  
Casimir effect, 37  
Causal dependence region of MRS, 278  
Causality, 16, 18, 42, 108, 121, 135, 146, 430  
Centre-of-mass system, cms, 16  
Chaotic limit, 252  
Classical electron radius, 25  
Classical turning point, 116  
Coherence, gluon bremsstrahlung, 292, 303  
Coherent limit, 253  
Coherent states, 40, 118, 253  
Color charges, 114, 134, 283, 329, 345, 346  
Color-flow direction, 282  
Commutator,  $\Delta$ , 42  
Compton wavelength, 25  
Confinement, 117, 126, 135, 146, 249  
Constituent and current quark, 225  
Cooper pair size,  $\xi$ , 127  
Coulomb potential, 97, 100  
Crossing symmetry, 73, 306, 406  
Current conservation, 70, 71  
Cut diagrams, 60, 77, 79  
  
Deep inelastic scattering, DIS, 106, 250, 392, 423  
DGLAP (Dokshitzer-Gribov Lipatov-Altarelli-Parisi) equation, 400, 409  
Dielectrics, 19  
Dipole cascade model, DCM, 318, 320, 333, 352  
Dipole emission cross section, 307  
Dipole size, 326  
Dipole virtuality, 326  
Diquarks, 242, 246, 344  
Directrix curve, 276, 318, 328, 331, 333, 347, 349, 351  
DIS events on a valence constituent, 423, 430  
DIS events on an ocean constituent, 424, 432  
Discrete QCD, 376  
Distribution, test-function, 20, 42, 45

- Dyson's propagator equation, 66, 75
- Elastic scattering, 16, 101
- Energy-momentum conservation, 146, 262
- Energy-momentum four-vector, 10
- Equation of motion for MRS, 269, 276
- Exclusive-inclusive formulas, 179
- External-part formulas, 158, 163
- Fermi motion, intrinsic transverse momentum, 429
- Fermi's Golden Rule, 50, 178
- Feynman path integrals, 221
- Feynman propagator,  $\Delta_F$ , 42, 43, 46, 53, 131, 195, 240, 245, 260
- Feynman-Wilson gas, 193, 207
- Fine structure constant, 24
- Finite-energy cluster, 154
- Flavor generation, 213, 289
- Flux factor, 24, 50, 51, 95, 110
- Flux quantisation, 132
- Form factor, 101, 105, 240, 297
- Formation time, 144, 291
- Four-vectors, 9
- Fractal dimensions in QCD cascades, 351, 390
- Fragmentation function in the Lund model, 151, 166, 177, 236, 289
- Fragmentation region, 169, 300
- Gain-loss equations, 86, 365
- Gauge invariance, 18, 71, 200, 203, 303, 306, 346
- Generalised Bessel functions  $\mathcal{I}$  and  $\mathcal{K}$ , 357, 374
- Gluon cascade, fluctuations, 334, 361
- Gluon cascade, self similarity, 331, 347
- Gluon emission process, 319, 328, 334, 338, 372
- Gluon fragmentation, Sjöstrand's, 288, 390
- Gluon model, the Lund, 269, 271
- Gluon phase space, generalised emission region, 325, 341, 342
- Gluon splitting process, 319, 338, 373
- Gluons in QCD, 8-charge, 318, 319
- Green's function method, 32, 358
- Gribov-Levin-Ruskin (GLR) model of shadowing, 400, 421
- Group velocity, 22
- Hagedorn spectrum, 161
- Hamilton's principle for the MRS, 281
- Hanbury-Brown-Twiss (HBT) effect, 249, 251
- Harmonic oscillator, 29, 97
- Heaviside distribution  $\Theta$ , 33, 43
- Heavy flavor fragmentation, 234, 235
- Heisenberg, 13, 48, 195, 240, 245
- Helicity conservation, 69, 73
- Hotspots in the wave function of a hadron, 401, 422
- Hyperbola breakup, 166, 254, 270, 299
- Hyperbola relation between adjacent vertices, 136
- Ideal gas law for rapidity gas in the Lund model, 209
- Impact parameter, 22
- Impact parameter dual to transverse momentum, 186
- Indeterminacy relations, 13, 48, 195, 240
- Index of refraction, 21
- Infinite momentum frame, 52, 240
- Infrared stability, 24, 269, 284, 295
- Initial-state bremsstrahlung (ISB), 400
- Internal-part formulas, 158, 163
- Isospin, 112
- Isotropic emission, 255
- Iterative cascade fragmentation models, 141, 168, 169, 359
- Jet of flavor-connected hadrons, 138
- Källén-Lehmann representation, 61, 68
- KNO scaling, 350, 358
- Kramers-Kronig relations, 22, 61
- L*-method for analytic  $\lambda$ -calculations, 350, 352
- Langevin equation, 219, 389
- Leading-log approximation (LLA), 351, 397, 400
- Left-right symmetry of Lund fragmentation, 158
- Lightcone components, 12
- Lightcone physics, 108, 399, 400
- Lightcone singularities, 43
- Lightlike vector, 14
- Linked dipole chain (LDC) model, 3, 423, 440
- Lipatov results, 413
- Local conservation of quantum numbers, 147
- Local field, 42
- Local parton-hadron duality, 352, 386
- London equations, 129
- Lorentz boost, 7
- Lorentz contraction, 9, 23, 291, 427
- Lorentz covariance, 9, 69, 72, 121, 273, 331
- Main momentum transfer flow, Feynman graph relevance, 433
- Marchesini-Webber model, HERWIG, 318, 334, 337, 339, 340, 349
- Markovian stochastic process, 141
- Mass renormalisation, 24, 67
- Massless relativistic string, MRS, 114, 213, 269, 423, 425, 430

- Maxwell equations, 18  
 Method of virtual quanta, 22, 93, 392  
 Minimal surface property of MRS, 269, 281  
 Minkowski space, 17  
 Modified leading-log approximation (MLLA), 351, 373  
 Moment method (MM) of Christ, Hasslacher and Mueller, 399, 403  
 Momentum and period translation of the MRS, 123, 273  
 Momentum transfer, 16  
 Mother-daughter relation, 227  
 Mott cross section, 100  
 Multiperipheral diagrams, 172, 192  
 Multiplicative renormalisation, 82  
  
 Normal-ordering, 30  
 Number of parameters of a model, 235, 244  
  
 Ocean quarks, 112  
 One-dimensional bag model, 229  
 One-particle irreducible diagrams, 65  
 Operator exponential, 31  
 Operator product expansion (OPE), 399, 403  
 Ordering variable, 321, 333, 346  
 Ornstein-Uhlenbeck process, 219, 352, 389  
  
 Partition function, statistical mechanics, 192, 207  
 Parton model, 90, 302  
 Partons as quarks, 111  
 Penetration depth  $\lambda$ , 127  
 Period of motion of the MRS, 120, 273  
 Peterson formula, 234, 236, 240  
 Phase-space triangle, 325, 341, 342, 352, 402  
 Phase velocity, 21  
 Plasma frequency, 21  
 Poisson distribution, 32  
 Polarisation, 249, 262  
 Pomeron trajectory, 190  
 Popcorn mechanism, 244  
 Poynting vector, 21  
 Proper time, 8, 288, 290  
     relation to momentum transfer, 164, 172  
 Pseudo-rapidity, 15  
  
 Quarkonia decay, 270, 296  
  
 Rank, for hadron in a cascade, 141, 147, 242  
 Rapidity, 11, 270  
 Rapidity density, 167  
 Rapidity gaps, 175  
 Rapidity plateau, 169  
 Recoil problems, 319, 345, 370  
     Kleiss' prescription, 345  
  
 Reduced matrix element, 72, 102  
 Regge theory, 177, 183, 189  
 Regge trajectory, 177, 190, 239, 347  
 Reggeon calculus, 185  
 Renormalisable field theories, 59, 71  
 Renormalisation group, 60, 83, 400, 407  
 Rosenbluth formula, 105, 111  
 Running coupling, 88, 89, 351, 398, 407  
     in QCD, 374  
 Rutherford scattering, 90, 95, 98  
 Rydberg energy, 98  
  
 Scalar quantum free field, 35  
 Scalars, 9  
 Scale breaking, 88, 399  
 Scattering cross sections, 49, 103, 192  
 Schwinger model, 117, 169, 171  
 Self-energy contribution, 68  
 Self-similarity, 331, 347, 390  
 Sign-distribution,  $\epsilon$ , 42  
 Sjöstrand cascade, JETSET, 318, 334, 337, 339, 340, 342, 349  
 Snow star curve, von Koch's, 390  
 Soft and collinear gluon emission, 295, 327, 344  
 Soft radiation model (SRM), 424, 434  
 Spacelike difference between vertices, 137  
 Spacelike vector, 15  
 Space-time area, mass of the MRS, 120, 281  
 Spectator relation, 171  
 Sphericity, 293  
 Spin-averaged matrix elements, 69, 72  
 Spin-orbit coupling, 265  
 Spin-spin interaction, 214, 228  
 Splitting functions, 319, 334, 338, 339, 410  
 State density, 36, 50, 52  
 Strangeness, 112  
 String effect, 290, 291, 319  
 Strong angular ordering, 440  
 Strong angular ordering condition, 303, 314, 319, 329, 331, 341, 344  
 Structure functions, 110  
 Sudakov form factor, 321, 340, 341  
 Super-renormalisable field theories, 58  
 Super-selection quantum numbers, 284  
 Superconductor type I, 'bag-type', 128  
 Superconductor type II, 'string type', 128  
 Superconductors, 126  
  
 The law of large numbers, 188  
 Thomas precession, 265  
 Thompson cross section, 25  
 Thrust, 294  
 Time dilation, 8, 403  
 Time dilation of tension of the MRS, 126  
 Time-ordering, 41

- Timelike vector, 14  
Transition rate, 50, 192  
Transverse correlation length, 219  
Transverse momentum generation, 213, 258, 262, 290  
Tunnelling, 192, 193, 214, 242  
  
UCLA model use of Lund fragmentation, 235, 247  
Unitarity equations of the  $S$ -matrix, 177, 180, 183  
  
Vacuum persistence probability, 195  
Valence quarks, 112  
Vector-to-pseudoscalar meson ratio, 214, 228  
Velocity, 9  
Vertex, for breakup of the MRS, 134  
  
Vertex proper time, area, 142, 148  
Virial expansion, 193  
Volume momentum cutoff, 36, 49, 62, 118  
Vortex line like the MRS, 132, 433, 435  
  
Webber-Marchesini fragmentation model, 319, 342, 343  
Weizsäcker-Williams method, 22  
Wick's theorem, 41  
Wilson phase operators, 192, 200  
WKB approximation, 194  
Wróblewski relation, 358  
  
 $x$ -curve, 351, 384  
  
Yoyo-mode of the MRS, 114, 119, 146

