

1. Record Nr.	UNISA996587865503316
Autore	Badger Simon
Titolo	Scattering Amplitudes in Quantum Field Theory
Pubbl/distr/stampa	Cham : , : Springer International Publishing AG, , 2024 ©2024
ISBN	3-031-46987-9
Edizione	[First edition.]
Descrizione fisica	1 online resource (312 pages)
Collana	Lecture Notes in Physics Series ; ; v.1021
Altri autori (Persone)	HennJohannes M PlefkaJan C ZoiaSimone
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Intro -- Preface -- Acknowledgements -- Contents -- Acronyms -- 1 Introduction and Foundations -- 1.1 Poincaré Group and Its Representations -- 1.2 Weyl and Dirac Spinors -- 1.3 Non-Abelian Gauge Theories -- 1.4 Feynman Rules for Non-Abelian Gauge Theories -- 1.5 Scalar QCD -- 1.6 Perturbative Quantum Gravity -- 1.7 Feynman Rules for Perturbative Quantum Gravity -- 1.8 Spinor-Helicity Formalism for Massless Particles -- 1.9 Polarisation of Massless Particles of Spin 1/2, 1 and 2 -- 1.10 Colour Decompositions for Gluon Amplitudes -- 1.10.1 Trace Basis -- 1.10.2 Structure Constant Basis -- 1.11 Colour-Ordered Amplitudes -- 1.11.1 Vanishing Tree Amplitudes -- 1.11.2 The Three-Gluon Tree-Amplitudes -- 1.11.3 Helicity Weight -- 1.11.4 Vanishing Graviton Tree-Amplitudes -- References -- 2 On-Shell Techniques for Tree-Level Amplitudes -- 2.1 Factorisation Properties of Tree-Level Amplitudes -- 2.1.1 Collinear Limits -- 2.1.2 Soft Theorems -- 2.1.3 Spinor-Helicity Formulation of Soft Theorems -- 2.1.4 Subleading Soft Theorems -- 2.2 BCFW Recursion for Gluon Amplitudes -- 2.2.1 Large z Falloff -- 2.3 BCFW Recursion for Gravity and Other Theories -- 2.4 MHV Amplitudes from the BCFW Recursion Relation -- 2.4.1 Proof of the Parke-Taylor Formula -- 2.4.2 The Four-Graviton MHV Amplitude -- 2.5 BCFW Recursion with Massive Particles -- 2.5.1 Four-Point Amplitudes with Gluons and Massive Scalars -- 2.6

Symmetries of Scattering Amplitudes -- 2.7 Double-Copy Relations for Gluon and Graviton Amplitudes -- 2.7.1 Lower-Point Examples -- 2.7.2 Colour-Kinematics Duality: A Four-Point Example -- 2.7.3 The Double-Copy Relation -- References -- 3 Loop Integrands and Amplitudes -- 3.1 Introduction to Loop Amplitudes -- 3.2 Unitarity and Cut Construction -- 3.3 Generalised Unitarity -- 3.4 Reduction Methods -- 3.4.1 Tensor Reduction. 3.4.2 Transverse Spaces and Transverse Integration -- 3.5 General Integral and Integrand Bases for One-Loop Amplitudes -- 3.5.1 The One-Loop Integral Basis -- 3.5.2 A One-Loop Integrand Basis in Four Dimensions -- 3.5.2.1 The Box Integrand in Four Dimensions -- 3.5.2.2 The Triangle Integrand in Four Dimensions -- 3.5.2.3 The Bubble Integrand in Four Dimensions -- 3.5.3 D-Dimensional Integrands and Rational Terms -- 3.5.3.1 The Pentagon Integrand -- 3.5.3.2 Extending the Box, Triangle and Bubble Integrand Basis to $D=4-2$ Dimensions -- 3.5.4 Final Expressions for One-Loop Amplitudes in D-Dimensions -- 3.5.5 The Direct Extraction Method -- 3.6 Project: Rational Terms of the Four-Gluon Amplitude -- 3.7 Outlook: Rational Representations of the External Kinematics -- 3.8 Outlook: Multi-Loop Amplitude Methods -- References -- 4 Loop Integration Techniques and Special Functions -- 4.1 Introduction to Loop Integrals -- 4.2 Conventions and Basic Methods -- 4.2.1 Conventions for Minkowski-Space Integrals -- 4.2.2 Divergences and Dimensional Regularisation -- 4.2.3 Statement of the General Problem -- 4.2.4 Feynman Parametrisation -- 4.2.5 Summary -- 4.3 Mellin-Barnes Techniques -- 4.3.1 Mellin-Barnes Representation of the One-Loop Box Integral -- 4.3.2 Resolution of Singularities in -- 4.4 Special Functions, Differential Equations, and Transcendental Weight -- 4.4.1 A First Look at Special Functions in Feynman Integrals -- 4.4.2 Special Functions from Differential Equations: The Dilogarithm -- 4.4.3 Comments on Properties of the Defining Differential Equations -- 4.4.4 Functional Identities and Symbol Method -- 4.4.5 What Differential Equations Do Feynman Integrals Satisfy? -- 4.5 Differential Equations for Feynman Integrals -- 4.5.1 Organisation of the Calculation in Terms of Integral Families -- 4.5.2 Obtaining the Differential Equations. 4.5.3 Dimensional Analysis and Integrability Check -- 4.5.4 Canonical Differential Equations -- 4.5.5 Solving the Differential Equations -- 4.6 Feynman Integrals of Uniform Transcendental Weight -- 4.6.1 Connection to Differential Equations and (Unitarity) Cuts -- 4.6.2 Integrals with Constant Leading Singularities and Uniform Weight Conjecture -- References -- 5 Solutions to the Exercises -- Exercise 1.1: Manipulating Spinor Indices -- Exercise 1.2: Massless Dirac Equation and Weyl Spinors -- Exercise 1.3: $SU(N_c)$ Identities -- Exercise 1.4: Casimir Operators -- Exercise 1.5: Spinor Identities -- Exercise 1.6: Lorentz Generators in the Spinor-Helicity Formalism -- Exercise 1.7: Gluon Polarisation -- Exercise 1.8: Colour-Ordered Feynman Rules -- Exercise 1.9: Independent Gluon Partial Amplitudes -- Exercise 1.10: The MHV3 Amplitude -- Exercise 1.11: Four-Point Quark-Gluon Scattering -- Exercise 2.1: The Vanishing Splitting Function $\text{Splittree}^+(x,a^+,b^+)$ -- Exercise 2.2: Soft Functions in the Spinor-Helicity Formalism -- Exercise 2.3: A $q\bar{q}g\bar{g}$ Amplitude from Collinear and Soft Limits -- Exercise 2.4: The Six-Gluon Split-Helicity NMHV Amplitude -- Exercise 2.5: Soft Limit of the Six-Gluon Split-Helicity Amplitude -- Exercise 2.6: Mixed-Helicity Four-Point Scalar-Gluon Amplitude -- Exercise 2.7: Conformal Algebra -- Exercise 2.8: Inversion and Special Conformal Transformations -- Exercise 2.9: Kinematical Jacobi Identity -- Exercise 2.10: Five-Point KLT Relation -- Exercise 3.1: The Four-Gluon Amplitude in $N=4$ Super-Symmetric

Yang-Mills Theory -- Exercise 3.2: Quadruple Cuts of Five-Gluon MHV Scattering Amplitudes -- Exercise 3.3: Tensor Decomposition of the Bubble Integral -- Exercise 3.4: Spurious Loop-Momentum Space for the Box Integral -- Exercise 3.5: Reducibility of the Pentagon in Four Dimensions -- Exercise 3.6: Parametrising the Bubble Integrand. Exercise 3.7: Dimension-Shifting Relation at One Loop -- Exercise 3.8: Projecting Out the Triangle Coefficients -- Exercise 3.9: Rank-One Triangle Reduction with Direct Extraction -- Exercise 3.10: Momentum-Twistor Parametrisations -- Exercise 4.1: The Massless Bubble Integral -- Exercise 4.2: Feynman Parametrisation -- Exercise 4.3: Taylor Series of the Log-Gamma Function -- Exercise 4.4: Finite Two-Dimensional Bubble Integral -- Exercise 4.5: Laurent Expansion of the Gamma Function -- Exercise 4.6: Massless One-Loop Box with Mellin-Barnes Parametrisation -- Exercise 4.7: Discontinuities -- Exercise 4.8: The Symbol of a Transcendental Function -- Exercise 4.9: Symbol Basis and Weight-Two Identities -- Exercise 4.10: Simplifying Functions Using the Symbol -- Exercise 4.11: The Massless Two-Loop Kite Integral -- Exercise 4.13: $d \log$ Form of the Massive Bubble Integrand with $D=2$ -- Exercise 4.14: An Integrand with Double Poles: The Two-Loop Kite in $D=4$ -- Exercise 4.16: The Box Integrals with the Differential Equations Method -- References -- A Conventions and Useful Formulae -- Reference.
