Quantum Yang Mills Theory The Physics Of Gauge Theory

The Conference “Perspectives in Analysis” was held during May 26–28, 2003 at the Royal Institute of Technology in Stockholm, Sweden. The purpose of the conference was to consider the future of analysis along with its relations to other areas of mathematics and physics, and to celebrate the seventy-?fth birthday of Lennart Carleson. The scienti?c theme was one with which the name of Lennart Carleson has been associated for over ?fty years. His modus operandi has long been to carry out a twofold approach to the selection of research problems. First one should look for promising new areas of ana- sis, especially those having close contact with physically oriented problems of geometric character. The second step is to select a core set of problems that require new techniques for their resolutions. After making a central contri- tion, Lennart would usually move on to a new area, though he might return to the topic of his previous work if new techniques were developed that could break old mathematical log jams. Lennart’s operating approach is based on fundamental realities of modern mathematics as well as his own inner c- victions. Here we ?rst refer to an empirical fact of mathematical research: All topics have a ?nite half-life, with ?fteen years being an upper bound for most areas. After that time it is usually a good idea to move on to so- thing new.

Now in paperback, this text provides a self-contained introduction to applications of loop representations and knot theory in particle physics and quantum gravity. Loop representations (and the related topic of knot theory) are of considerable current interest because they provide a unified arena for the study of the gauge invariant quantization of Yang-Mills theories and gravity, and suggest a promising approach to the eventual unification of the four fundamental forces. This text begins with a detailed review of loop representation theory. It then goes on to describe loop representations in Maxwell theory, Yang-Mills theories as well as lattice techniques. Applications in quantum gravity are then discussed in detail. Following chapters move on to consider knot theories, braid theories and extended loop representations in quantum gravity. A final chapter assesses the current status of the theory and points out possible directions for future research.

This book tells mathematicians about an amazing subject invented by physicists and it tells physicists how a master mathematician must proceed in order to understand it. Physicists who know quantum field theory can learn the powerful methodology of mathematical structure, while mathematicians can position themselves to use the magical ideas of quantum field theory in "mathematics" itself. The retelling of the tale mathematically by Kevin Costello is a beautiful tour de force. --Dennis Sullivan This book is quite a remarkable contribution. It should make perturbative quantum field theory accessible to mathematicians. There is a lot of insight in the way the author uses the renormalization group and effective field theory to analyze perturbative renormalization; this may serve as a springboard to a wider use of those topics, hopefully to an eventual nonperturbative understanding. --Edward Witten Quantum field theory has had a profound influence on mathematics, and on geometry in particular. However, the notorious difficulties of renormalization have made quantum field theory very inaccessible for mathematicians. This book provides complete mathematical foundations for the theory of perturbative quantum field theory, based on Wilson's ideas of low-energy effective field theory and on the Batalin- Vilkovisky formalism. As an example, a cohomological proof of perturbative renormalizability of Yang-Mills theory is presented. An effort has been made to make the book accessible to mathematicians who have had no prior exposure to quantum field theory. Graduate students who have taken classes in basic functional analysis and homological algebra should be able to read this book.

After the great success of perturbative methods in Quantum Field Theory in 1970s, physicists get faced with difficulties of non-perturbative analysis. In same 1970s the concept of supersymmetry appeared. It was realized soon that quantum corrections are controlled by supersymmetry via non-renormalization theorems. The natural idea was, therefore, to use supersymmetric theories as a laboratory for non-perturbative effects, especially for the gauge theories, which are believed to describe Electroweak and Strong Interactions. In this book the N=2 super Yang-Mills theories are considered. Their non-perturbative behavior is both highly non-trivial and tractable. Historically first solution for these models was provided by Seiberg-Witten theory. In early 2000s the microscopic derivation of this theory was obtained by Nekrasov through the Instanton Counting method. This method is the main subject of the book. The detailed explanations of basic concepts together with various results are presented. The book can be interesting for graduate students and researchers, working in Quantum Field Theory.

A Convergent Continuum Strong Coupling Expansion for Quantum Mechanics Quantum Field Theory/ String Tensions in Deformed Yang-Mills Theory

The Quantum Theory of Nonabelian Monopoles

Quantum Field Theory about a Yang-Mills Pseudoparticle

The Thermodynamics of Quantum Yang-Mills Theory

The Dawning of Gauge Theory

Advanced Topics in Quantum Field Theory

Based on a highly regarded lecture course at Moscow State University, this is a clear and systematic introduction to gauge field theory. It is unique in providing the means to master gauge field theory prior to the advanced study of quantum mechanics. Though gauge field theory is typically included in courses on quantum field theory, many of its ideas and results can be understood at the classical or semi-classical level. Accordingly, this book is organized so that its early chapters require no special knowledge of quantum mechanics. Aspects of gauge field theory relying on quantum mechanics are introduced only later and in a graduated fashion--making the text ideal for students studying gauge field theory and quantum mechanics simultaneously. The book begins with the basic concepts on which gauge field theory is built. It introduces gauge-invariant Lagrangians and describes the spectra of linear perturbations, including perturbations above nontrivial ground states. The second part focuses on the construction and interpretation of classical solutions that exist entirely due to the

nonlinearity of field equations: solitons, bounces, instantons, and sphalerons. The third section considers some of the interesting effects that appear due to interactions of fermions with topological scalar and gauge fields. Mathematical digressions and numerous problems are included throughout. An appendix sketches the role of instantons as saddle points of Euclidean functional integral and related topics. Perfectly suited as an advanced undergraduate or beginning graduate text, this book is an excellent starting point for anyone seeking to understand gauge fields.

Since the advent of Yang–Mills theories and supersymmetry in the 1970s, quantum field theory - the basis of the modern description of physical phenomena at the fundamental level - has undergone revolutionary developments. This is the first systematic and comprehensive text devoted specifically to modern field theory, bringing readers to the cutting edge of current research. The book emphasizes nonperturbative phenomena and supersymmetry. It includes a thorough discussion of various phases of gauge theories, extended objects and their quantization, and global supersymmetry from a modern perspective. Featuring extensive cross-referencing from traditional topics to recent breakthroughs in the field, it prepares students for independent research. The side boxes summarizing the main results and over 70 exercises make this an indispensable book for graduate students and researchers in theoretical physics.

This book provides an introduction to topological quantum field theory as well as discrete gauge theory with quantum groups. In contrast to much of the existing literature, the present approach is at the same time intuitive and mathematically rigorous, making extensive use of suitable diagrammatic methods. It provides a highly unified description of lattice gauge theory, topological quantum field theory and models of quantum (super)gravity. The reader is thus in a unique position to understand the relations between these subjects as well as the underlying groundwork.

During the course of this century, gauge invariance has slowly emerged from being an incidental symmetry of electromagnetism to being a fundamental geometrical principle underlying the four known fundamental physical interactions. The development has been in two stages. In the first stage (1916-1956) the geometrical significance of gauge-invariance gradually came to be appreciated and the original abelian gauge-invariance of electromagnetism was generalized to non-abelian gauge invariance. In the second stage (1960-1975) it was found that, contrary to first appearances, the non-abelian gauge-theories provided exactly the framework that was needed to describe the nuclear interactions (both weak and strong) and thus provided a universal framework for describing all known fundamental interactions. In this work, Lochlainn O'Raifeartaigh describes the former phase. O'Raifeartaigh first illustrates how gravitational theory and quantum mechanics played crucial roles in the reassessment of gauge theory as a geometric principle and as a framework for describing both electromagnetism and gravitation. He then describes how the abelian electromagnetic gauge-theory was generalized to its present non-abelian form. The development is illustrated by including a selection of relevant articles, many of them appearing here for the first time in English, notably by Weyl, Schrodinger, Klein, and London in the pre-war years, and by Pauli, Shaw, Yang-Mills, and Utiyama after the war. The articles illustrate that the reassessment of gauge-theory, due in a large measure to Weyl, constituted a major philosophical as well as technical advance.

Classical Theory of Gauge Fields

From Lattices to TQFT

Non-linear and Collective Phenomena in Quantum Physics

Quantum Yang-Mills Theory on Arbitrary Surfaces

100 Years of Gravity and Accelerated Frames

Divergences in Quantum Gravity and Supersymmetric Yang-Mills Theory

Approximately fifty articles that were published in The Mathematical Intelligencer during its first eighteen years. The selection demonstrates the wide variety of attractive articles that have appeared over the years, ranging from general interest articles of a historical nature to lucid expositions of important current discoveries. Each article is introduced by the editors. "...The Mathematical Intelligencer publishes stylish, well-illustrated articles, rich in ideas and usually short on proofs. ...Many, but not all articles fall within the reach of the advanced undergraduate mathematics major. ... This book makes a nice addition to any undergraduate mathematics collection that does not already sport back issues of The Mathematical Intelligencer." D.V. Feldman, University of New Hamphire, CHOICE Reviews, June 2001.

"Reinventing Discovery argues that we are in the early days of the most dramatic change in how science is done in more than 300 years. This change is being driven by new online tools, which are transforming and radically accelerating scientific discovery"--

Homotopy Quantum Field Theory (HQFT) is a branch of Topological Quantum Field Theory founded by E. Witten and M. Atiyah. It applies ideas from theoretical physics to study principal bundles over manifolds and, more generally, homotopy classes of maps from manifolds to a fixed target space. This book is the first systematic exposition of Homotopy Quantum Field Theory. It starts with a formal definition of an HQFT and provides examples of HQFTs in all dimensions. The main body of the text is focused on 2-dimensional and 3-dimensional HQFTs. A study of these HQFTs leads to new algebraic objects: crossed Frobenius group-algebras, crossed ribbon group-categories, and Hopf group-coalgebras. These notions and their connections with HQFTs are discussed in detail. The text ends with several appendices including an outline of recent developments and a list of open problems. Three appendices by M. Muger and A. Virelizier

summarize their work in this area. The book is addressed to mathematicians, theoretical physicists, and graduate students interested in topological aspects of quantum field theory. The exposition is self-contained and well suited for a one-semester graduate course. Prerequisites include only basics of algebra and topology.

This textbook grew out of lecture notes the author used in delivering a quantum field theory (QFT) course for students (both in high energy physics and condensed matter) who already had an initial exposure to the subject.It begins with the path integral method of quantization presented in a systematic and clear-cut manner. Perturbation theory is generalized beyond tree level, to include radiative corrections (loops). Renormalization procedures and the Wilsonian renormalization group (RG flow) are discussed, asymptotic freedom of non-Abelian gauge theories is derived, and some applications in Quantum Chromodynamics (QCD) are considered, with a brief digression into the Standard Model (SM). The SM case requires a study of the spontaneous breaking of gauge symmetry, a phenomenon which would be more appropriate to call 'Higgsing of the gauge bosons.' Other regimes attainable in gauge theories are explained as well. In the condensed matter part, the Heisenberg and Ising model are discussed. The present textbook differs from many others in that it is relatively concise and, at the same time, teaches students to carry out actual calculations which they may encounter in QFT-related applications.

Selections from The Mathematical Intelligencer

Essays in Honor of Lennart Carleson's 75th Birthday

Maxwell Fields, Volume I

Reinventing Discovery

An Introduction To Quantum Theory, Second Edition

Theory and Applications

Contents: Extended Systems in Field Theory :Introduction (J-L Gervais and A Neveu)Vortices and Quark Confinement in Non-Abelian Gauge Theories (S Mandelstam)Magnetic and Electric Confinement of Quarks (Y Nambu)Examples of Four-Dimensional Soliton Solutions and Abnormal Nuclear States (T D Lee)Classical Solution in the Massive Thirring Model (S-J Chang)Semiclassical Quantization Methods in Field Theory (A Neveu)The Quantum Theory of Solitons and Other Non-Linear Classical Waves (R Jackiw)Collective Coordinate Method for Quantization of Extended Systems (J-L Gervais, A Jevicki and B Sakita)Quantum Expansion of Soliton Solutions (N H Christ)Hartree-Type Approximation Applied to a ϕ4 Field Theory (S-J Chang)Soliton Operators for the Quantized Sine-Gordon Equation (S Mandelstam)Classical Aspects and Fluctuation-Behaviour of Two Dimensional Models in Statistical Mechanics and Many Body Physics (B Schroer)Quarks on a Lattice, or, the Colored String Model (K G Wilson)New Ideas about Confinement (L Susskind and J Kogut)Gauge Fields on a Lattice (C Itzykson)Non-Perturbative Aspects in Quantum Field Theory:Self-Dual Solutions to Euclidean Yang-Mills Equations (E Corrigan)An Introduction to the Twistor Programme (J Madore, J L Richard and R Stora)Collective Coordinates with Non-Trivial Dynamics (J-L Gervais)A Theory of the Strong Interactions (D J Gross)Magneticmonopoles (D Olive)Dynamical and Topological Considerations on Quark Confinement (F Englert and P Windey)Difficulties in Fixing the Gauge in Non-Abelian Gauge Theories (S Sciuto)Indeterminate-Mass Particles (B M Mccoy and T T Wu)Duality for Discrete Lattice Gauge Fields (C Itzykson)Large Order Estimates in Perturbation Theory (J Zinn-Justin)The Borel Transform and the Renormalization Group (G Parisi)Planar Diagrams (E Brezin)Exact S-Matrices and Form Factors in 1 + 1 Dimensional Field Theoretic Models with Soliton Behaviour (M Karowski)Topology and Higher Symmetries of the Two-Dimensional Nonlinear σ Model (A D'adda, M Luscher and P Di Vecchia)Two-Dimensional Yang-Mills Theory in the Leading 1/N Expansion (T T Wu)Superfluidity and the Two-Dimensional XY Model' (D R Nelson)Bosonized Fermions in Three Dimensions (A Luther)Symmetry and Topology Concepts for Spin Glasses and Other Glasses (G Toulouse)Common Trends in Particle and Condensed Matter Physics:Introduction to Localization(D J Thouless)Conductivity Scaling and Localization(E Abrahams)Disordered Electronic System as a Model of Interacting Matrices(F Wegner)Status Report on Spin Glasses (Not Included in this Report)(S Kirkpatrick)Mean Field Theory for Spin Glasses(G Parisi)The Random Energy Model(B Derrida)Towards a Mean Field Theory of Spin Glasses: the Tap Route Revisited (C De Dominicis)On the Connection Between Spin Glasses and Gauge Field Theories(G Toulouse, J Vannimenus)Monte Carlo Simulations of Lattice Gauge Theories(C Rebbi)Large Dimension Expansions and Transition Patterns in Lattice Gauge Theories(J-M Drouffe)Progress in Lattice Gauge Theory(J B Kogut)Phase Structure of the Z(2) Gauge and Matter Theory(D Horn)General Introduction to Confinement(S Mandelstam)A Simple Picture of the Weak-to-Strong Coupling Transition in Quantum Chromodynamics(C G Callan Jr.)Quantum Fluctuations in a Multiinstanton Background(B A Berg)Some Comments on the Crossover Between Strong and Weak Coupling in Su(2) Pure Yang-Mills Theory(J Frohlich)String Dynamics in QCD (J-L Gervais, A Neveu)Dual Models and Strings: The Critical Dimension(C B Thorn:)Duality and Finite Size Effects in Six Vertex Models(C.B. Thorn:)Scaling at a Bifurcation Point(M Nauenberg, D Scalapino)Some Implications of a Cosmological Phase Transition(T W B Kibble) Readership: Graduate students and researchers in particle physics andcondensed matter physics.

This Thesis is a collection of three different works: "A Convergent Continuum Strong Coupling Expansion For Quantum Mechanics \ Quantum Field Theory": The notion of an asymptotic weak coupling expansion about an exactly solvable model in QM and QFT is generalized to an all positive value coupling convergent expansion. This is done by rescaling the variables available

in the theory by free parameters, then adding and subtracting the exactly solvable model. The rest (initial rescaled theory by free parameters + the subtracted exactly solvable model) is expanded about the added exactly solvable model. Evaluating finite orders of this expansion at its extremum points with respect to the free parameter(s) gives a sequence that converges to the result of the previous asymptotic expansion. This method is applied to quantum mechanics and quantum field theory. The electron g-factor calculation is improved at the one loop level using this method. "String Tensions in Deformed Yang-Mills Theory": Yang-Mills theory defined on $\mathbb{R}^3 \times S^1$ deconfines at high temperatures or small circle sizes S^1. In order to have a confining theory for arbitrary small spacial circle sizes S^1 that can be studied analytically a deformation of Yang-Mills theory is considered. In this work we calculate the k-string tensions for SU(N) deformed Yang-Mills theory on $\mathbb{R}^3 \times S^1$. The k-string tensions T_k for $2 \leq N \leq 10$ are calculated in two different ways: by a numerical minimization and a (novel) analytical evaluation of the string tension action. We find that dYM k-string ratios T_k/T_1 do not obey the well-known sine- or Casimir-scaling laws. Instead, we show that the ratios T_k/T_1 are bound above by a square root of Casimir scaling, previously found to hold for stringlike solutions of the MIT Bag Model. Our results also indicate that, at large values of N, k-strings in dYM do not become free. "A Generalization of Picard-Lindelof Theorem/ The Method of Characteristics to Systems of PDE": Picard-Lindelof theorem of ordinary differential equations and the method of characteristics is unified/generalized to the following system of PDE: $C_{il}(x,y) {\partial y_i / \partial x_l} + {\partial y_i / \partial x_m} = D_i(x,y)$.

The Roman Catholic faith has inspired some of the world's greatest creative works and has been a powerful force in history from the Roman Empire to the present. Catholic writers reflect their heritage in their works, and generations of readers have continued to appreciate the Catholic literary tradition. Many works by Catholic writers hold a high place in the literary canon and have exerted a tremendous cultural and political influence. Still others continue to be widely read by contemporary readers and quietly shape modern society. Some works, too, reflect the conflicts of the Catholic Church in the 21st century and capture the struggles of individual Catholics in a secular society. This encyclopedia covers the vast riches of the Catholic literary tradition from its origins to the present day. Included are substantial entries on more than 70 major works from around the world. A special effort has been made to cover women writers and writers of diverse racial and ethnic backgrounds, whose works reflect the many dimensions of the Catholic experience. The encyclopedia provides entries on such writers and works as St. Augustine's Confessions, Catherine of Siena's Dialogue, Dante's The Divine Comedy, Sandra Cisneros' The House on Mango Street, J.R.R. Tolkien's The Lord of the Rings, and Muriel Spark's Memento Mori. Each entry is written by an expert contributor and includes a biography of the writer, a plot summary of a major work, an extended critical discussion, an overview of the work's critical reception, and a selected bibliography. The entries give detailed attention to particular works and explore their relation to Catholic thought. The encyclopedia concludes with a selected, general bibliography.

This book provides a thorough description of the manifestly covariant canonical formalism of the abelian and non-abelian gauge theories and quantum gravity. The emphasis is on its non-perturbative nature and the non-use of the path-integral approach. The formalism presented here is extremely beautiful and transparent.

60 Years of YangCMills Gauge Field Theories

A Lecture Course

Second Edition

Quantum Field Theory Ii

Discrete Gauge Theory

Perspectives in Analysis

This latest edition enhances the material of the first edition with a derivation of the value of the action for each of the Harrington–Shepard calorons/anticalorons that are relevant for the emergence of the thermal ground state. Also included are discussions of the caloron center versus its periphery, the role of the thermal ground state in U(1) wave propagation, photonic particle–wave duality, and calculational intricacies and book-keeping related to one-loop scattering of massless modes in the deconfining phase of an SU(2) Yang–Mills theory. Moreover, a derivation of the temperature–redshift relation of the CMB in deconfining SU(2) Yang–Mills thermodynamics and its application to explaining an apparent early re-ionization of the Universe are given. Finally, a mechanism of mass generation for cosmic neutrinos is proposed. Contents: Theory:The Classical Yang–Mills ActionThe Perturbative Approach at Zero TemperatureAspects of Finite-Temperature Field TheorySelfdual Field ConfigurationsThe Deconfining PhaseThe Preconfining PhaseThe Confining PhaseApplications:The Approach of Thermal Lattice Gauge TheoryBlack-Body AnomalyAstrophysical and Cosmological Implications of SU(2)CMB Readership: Advanced students, postdocs and researchers in theoretical physics and mathematics, as well as experimentalists.

YangOCoMills gravity is a new theory, consistent with experiments, that brings gravity back to the arena of gauge field theory and quantum mechanics in flat space-time. It provides solutions to long-standing difficulties in physics, such as the incompatibility between Einstein''s principle of general coordinate invariance and modern schemes for a quantum mechanical description of nature, and Noether''s OCyTheorem IIOCO which showed that the principle of general coordinate invariance in general relativity leads to the failure of the law of conservation of energy. YangOCoMills gravity in flat space-time appears to be more

physically coherent than conventional gravity in curved space-time. The problems of quantization of the gravitational field, the operational meaning of space-time coordinates and momenta, and the conservation of energy-momentum are all resolved in YangOCoMills gravity.The aim of this book is to provide a treatment of quantum YangOCoMills gravity, with an emphasis on the ideas and evidence that the gravitational field is the manifestation of space-time translational symmetry in flat space-time, and that there exists a fundamental space-time symmetry framework that can encompass all of physics, including gravity, for all inertial and non-inertial frames of reference.

This collection of papers presents ideas and problems arising over the past 100 years regarding classical and quantum gravity, gauge theories of gravity, and spacetime transformations of accelerated frames. Both Einstein's theory of gravity and the Yang-Mills theory are gauge invariant. The invariance principles in physics have transcended both kinetic and dynamic properties and are at the very heart of our understanding of the physical world. In this spirit, this book attempts to survey the development of various formulations for gravitational and Yang-Mills fields and spacetime transformations of accelerated frames, and to reveal their associated problems and limitations.The aim is to present some of the leading ideas and problems discussed by physicists and mathematicians. We highlight three aspects: formulations of gravity as a Yang-Mills field, first discussed by Utiyama; problems of gravitational theory, discussed by Feynman, Dyson and others; spacetime properties and the physics of fields and particles in accelerated frames of reference.These unfulfilled aspects of Einstein and Yang-Mills' profound thoughts present a great challenge to physicists and mathematicians in the 21st century.

This book comprises the second half of a quantum field theory (QFT) course for graduate students. It gives a concise introduction to advanced concepts that are important for research in elementary particle theory. Topics include the path integral, loop expansion, Feynman rules, various regularization methods, renormalization, running couplings and the renormalization group, fixed points and asymptotic freedom, effective action, Coleman-Weinberg effective potential, fermions, the axial anomaly, QED, gauge fixing, nonabelian gauge theories, unitarity, optical theorem, Slavnov-Taylor identities, beta function of Yang-Mills theory, a heuristic derivation of asymptotic freedom, instantons in SU(N) gauge theory, theta vacua and the strong CP problem. Exercises are included and are intended for advanced graduate students or postdocs seeking to deepen their understanding of QFT.

Space-time Symmetry and Quantum Yang-Mills Gravity

The Deepest Insights of Einstein and Yang-Mills

How Space-time Translational Gauge Symmetry Enables the Unification of Gravity with Other Forces

Dual Yang-Mills Theory

Strong Connections and Uq(2)-Yang-Mills Theory on Quantum Principal Bundles

Homotopy Quantum Field Theory

The Thermodynamics of Quantum YangCMills TheoryTheory and ApplicationsWorld Scientific

Quantum physics and special relativity theory were two of the greatest breakthroughs in physics during the twentieth century and contributed to paradigm shifts in physics. This book combines these two discoveries to provide a complete description of the fundamentals of relativistic quantum physics, guiding the reader effortlessly from relativistic quantum mechanics to basic quantum field theory. The book gives a thorough and detailed treatment of the subject, beginning with the classification of particles, the Klein–Gordon equation and the Dirac equation. It then moves on to the canonical quantization procedure of the Klein–Gordon, Dirac and electromagnetic fields. Classical Yang–Mills theory, the LSZ formalism, perturbation theory, elementary processes in QED are introduced, and regularization, renormalization and radiative corrections are explored. With exercises scattered through the text and problems at the end of most chapters, the book is ideal for advanced undergraduate and graduate students in theoretical physics.

A modern introduction to quantum field theory for graduates, providing intuitive, physical explanations supported by real-world applications and homework problems.

During the last six decades, Yang-Mills theory has increasingly become the cornerstone of theoretical physics. It is seemingly the only fully consistent relativistic quantum many-body theory in four space-time dimensions. As such it is the underlying theoretical framework for the Standard Model of Particle Physics, which has been shown to be the correct theory at the energies we now can measure. It has been investigated also from many other perspectives, and many new and unexpected features have been uncovered from this theory. In recent decades, apart from high energy physics, the theory has been actively applied in other branches of physics, such as statistical physics, condensed matter physics, nonlinear systems, etc. This makes the theory an indispensable topic for all who are involved in physics. The conference celebrated the exceptional achievements using Yang-Mills theory over the years but also many other truly remarkable contributions to different branches of physics from Prof C N Yang. This volume collects the invaluable talks by Prof C N Yang and the invited speakers reviewing these remarkable contributions and their importance for the future of physics. Contents:The Future of Physics — Revisited (C N Yang)Quantum Chromodynamics — The Perfect Yang-Mills Gauge Field Theory (David Gross)Maximally Supersymmetric Yang-Mills Theory: The Story of N = 4 Yang-Mills Theory (Lars Brink)The Lattice and Quantized Yang-Mills Theory (Michael Creutz)Yang-Mills Theories at High Energy Accelerators (George Sterman)Yang-Mills Theory at 60: Milestones,

Landmarks and Interesting Questions (Ling-Lie Chau)Discovery of the First Yang-Mills Gauge Particle — The Gluon (Sau Lan Wu)Yang-Mills Gauge Theory and Higgs Particle (Tai Tsun Wu & Sau Lan Wu)Scenario for the Renormalization in the 4D Yang-Mills Theory (L D Faddeev)Statistical Physics in the Oeuvre of Chen Ning Yang (Michael E Fisher)Quantum Vorticity in Nature (Kerson Huang)Yang-Mills Theory and Fermionic Path Integrals (Kazuo Fujikawa)Yang-Mills Gauge Theory and the Higgs Boson Family (Ngee-Pong Chang)On the Physics of the Minimal Length: The Questions of Gauge Invariance (Lay Nam Chang, Djordje Minic, Ahmed Roman, Chen Sun & Tatsu Takeuchi)Generalization of the Yang-Mills Theory (G Savvidy)Some Thoughts about Yang-Mills Theory (A Zee)Gauging Quantum Groups: Yang-Baxter Joining Yang-Mills (Yong-Shi Wu)The Framed Standard Model (I) — A Physics Case for Framing the Yang-Mills Theory? (Chan Hong-Mo & Tsou Sheung Tsun)The Framed Standard Model (II) — A First Test Against Experiment (Chan Hong-Mo & Tsou Sheung Tsun)On the Study of the Higgs Properties at a Muon Collider (Mario Greco)Aharonov-Bohm Types of Phases in Maxwell and Yang-Mills Field Theories (Bruce H J McKellar)Yang-Mills for Historians and Philosophers (R P Crease)Gauge Concepts in Theoretical Applied Physics (Seng Ghee Tan & Mansoor B A Jalil)Yang-Yang Equilibrium Statistical Mechanics: A Brilliant Method (Xi-Wen Guan & Yang-Yang Chen)Chern-Simons Theory, Vassiliev Invariants, Loop Quantum Gravity and Functional Integration Without Integration (Louis H Kauffman)The Scattering Equations and Their Off-Shell Extension (York-Peng Yao)Feynman Geometries (Sen Hu & Andrey Losev)Particle Accelerator Development: Selected Examples (Jie Wei)A New Storage-Ring Light Source (Alex Chao)New Contributions to Physics by Prof C N Yang: 2009-2011 (Zhong-Qi Ma)Brief Overview of C N Yang's 13 Important Contributions to Physics (Yu Shi)
Readership: Graduate students and scientists working in high energy physics, statistical physics and condensed matter physics.
Advanced Concepts in Quantum Field Theory

Loops, Knots, Gauge Theories and Quantum Gravity
Covariant Operator Formalism Of Gauge Theories And Quantum Gravity
Instanton Counting in N=2 Super Yang-Mills Theories
Floer Homology Groups in Yang-Mills Theory

The concept of Floer homology was one of the most striking developments in differential geometry. It yields rigorously defined invariants which can be viewed as homology groups of infinite-dimensional cycles. The ideas led to great advances in the areas of low-dimensional topology and symplectic geometry and are intimately related to developments in Quantum Field Theory. The first half of this book gives a thorough account of Floer's construction in the context of gauge theory over 3 and 4-dimensional manifolds. The second half works out some further technical developments of the theory, and the final chapter outlines some research developments for the future - including a discussion of the appearance of modular forms in the theory. The scope of the material in this book means that it will appeal to graduate students as well as those on the frontiers of the subject.

This is original, well-written work of interest Presents for the first time (physical) field theories written in sheaf-theoretic language Contains a wealth of minutely detailed, rigorous computations, ususally absent from standard physical treatments Author's mastery of the subject and the rigorous treatment of this text make it invaluable

A fully updated edition of the classic text by acclaimed physicist A. Zee Since it was first published, Quantum Field Theory in a Nutshell has quickly established itself as the most accessible and comprehensive introduction to this profound and deeply fascinating area of theoretical physics. Now in this fully revised and expanded edition, A. Zee covers the latest advances while providing a solid conceptual foundation for students to build on, making this the most up-to-date and modern textbook on quantum field theory available. This expanded edition features several additional chapters, as well as an entirely new section describing recent developments in quantum field theory such as gravitational waves, the helicity spinor formalism, on-shell gluon scattering, recursion relations for amplitudes with complex momenta, and the hidden connection between Yang-Mills theory and Einstein gravity. Zee also provides added exercises, explanations, and examples, as well as detailed appendices, solutions to selected exercises, and suggestions for further reading. The most accessible and comprehensive introductory textbook available Features a fully revised, updated, and expanded text Covers the latest exciting advances in the field Includes new exercises Offers a one-of-a-kind resource for students and researchers Leading universities that have adopted this book include: Arizona State University Boston University Brandeis University Brown University California Institute of Technology Carnegie Mellon College of William & Mary Cornell Harvard University Massachusetts Institute of Technology Northwestern University Ohio State University Princeton University Purdue University - Main Campus Rensselaer Polytechnic Institute Rutgers University - New Brunswick Stanford University University of California - Berkeley University of Central Florida University of Chicago University of Michigan University of Montreal University of Notre Dame Vanderbilt University Virginia Tech University

This volume deals with canonical quantization, Feynman rules and renormalization of Yang-Mills theories in algebraic non-covariant gauges (typically axial and light-cone gauges). The material is self-contained and presented in a basic manner according to a personal style representative of a long lasting activity in the field. Emphasis is always placed on the underlying basic concepts of Quantum Field Theory, even when particular examples are treated, details and the related difficulties are thoroughly discussed. The value of the book goes beyond the specificity of its subject.

Modern Differential Geometry in Gauge Theories
Gauge Fields
The New Era of Networked Science
C N Yang's Contributions to Physics
Frontiers In Quantum Field Theory

Yang-Mills Theory in Gauge-invariant Variables and Geometric Formulation of Quantum Field Theories

Frontiers in Quantum Field Theory is published in honor of Prof Keiji Kikkawa's 60th birthday. It deals with modern quantum field theory in the context of several exciting recent developments, many of them inspired or influenced by Prof Kikkawa's work, which include dualities in string theory and field theory, matrix models and noncritical strings, lower dimensional quantum gravity, topological and superconformal field theory.

On the 50th anniversary of YangOCoMills theory, this invaluable volume looks back at the developments and achievements in elementary particle physics that ensued from that beautiful idea. During the last five decades, Yang-Mills theory, which is undeniably the most important cornerstone of theoretical physics, has expanded widely. It has been investigated from many perspectives, and many new and unexpected features have been uncovered from this theory. In recent decades, apart from high energy physics, the theory has been actively applied in other branches of physics, such as statistical physics, condensed matter physics, nonlinear systems, etc. This makes the theory an indispensable topic for all who are involved in physics. An international team of experts, each of whom has left his mark on the developments of this remarkable theory, contribute essays or more detailed technical accounts to this volume. These articles highlight the new discoveries from the respective authorsOCO perspectives. The distinguished contributors are: S Adler, F A Bais, C Becchi, M Creutz, A De Rjula, B S DeWitt, F Englert, L D Faddeev, P Hasenfratz, R Jackiw, A Polyakov, V N Popov, R Stora, P van Baal, P van Nieuwenhuizen, S Weinberg, F Wilczek, E Witten, C N Yang. Included in each article are introductory and explanatory remarks by the editor, G OCOt Hooft, who is himself a major player in the development of Yang-Mills theory."

First Published in 2018. Routledge is an imprint of Taylor & Francis, an Informa company.

This book aims to provide advanced students and researchers with the text on a nonperturbative, thermodynamically grounded, and largely analytical approach to four-dimensional Quantum Gauge Theory. It also covers terrestrial, astrophysical, and cosmological applications, mostly within the realm of low-temperature photon physics

A Reprint Volume from Physics Reports

Gauge Quantum Models of Massive Electrodynamics, Massive Yang-Mills Theory and Massive Superparticle N

From Advanced Quantum Mechanics to Introductory Quantum Field Theory

Quantum Field Theory in a Nutshell

Canonical Quantization and Renormalization

Relativistic Quantum Physics

This book aims to provide advanced students and researchers with the text on a nonperturbative, thermodynamically grounded, and largely analytical approach to four-dimensional Quantum Gauge Theory. The terrestrial, astrophysical, and cosmological applications, mostly within the realm of low-temperature photon physics, are treated.

Yang-Mills Theories in Algebraic Non-covariant Gauges

Renormalization and Effective Field Theory

With Exercises

The Thermodynamics of Quantum YangCMills Theory

Mathematical Conversations

Quantum Field Theory and the Standard Model