Quantum Fields And Strings A Course For Mathematicians

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Quantum Fields And Strings A Course For Mathematicians ***2021-11-28***

PERKINS HARRINGTON

Quantum Fields and Strings Springer Science & Business Media
Since its conception in the 1960s, string theory has been hailed as one of the most promising routes we have to unify quantum mechanics and general relativity. This book provides a concise introduction to string theory explaining central concepts, mathematical tools and covering recent developments in physics including compactifications and gauge/string dualities. With string theory being a multidisciplinary field interfacing with high energy physics, mathematics and quantum field theory, this book is ideal for both students with no previous knowledge of the field and scholars from other disciplines who are looking for an introduction to basic concepts.
Strings, Gauge Fields, and the Geometry Behind Springer
This book presents a string-theoretic approach to new ideas in particle physics, also known as Physics Beyond the Standard Model, and to cosmology. The concept of Naturalness and its apparent violation by the low electroweak scale and the small cosmological constant is emphasized. It is shown that string theory,

through its multitude of solutions, known as the landscape, offers a partial resolution to these naturalness problems as well as suggesting more speculative possibilities like that of a multiverse. The book is based on a one-semester course, as such, it has a pedagogical approach, is self-contained and includes many exercises with solutions. Notably, the basics of string theory are introduced as part of the lectures. These notes are aimed at graduate students with a solid background in quantum field theory, as well as at young researchers from theoretical particle physics to mathematical physics. This text also benefits students who are in the process of studying string theory at a deeper level. In this case, the volume serves as additional reading beyond a formal string theory course.

Quantum Field Theory for the Gifted Amateur CRC Press

The aim of this book is to provide the reader with an introduction to conformal field theory and its applications to topology. The author starts with a description of geometric aspects of conformal field theory based on loop groups. By means of the holonomy of conformal field theory he defines topological invariants for knots and 3-manifolds. He also gives a brief treatment of Chern-Simons perturbation theory.

Springer Nature

This textbook provides an introduction to string field theory (SFT). String theory is usually formulated in the worldsheet formalism, which describes a single string (first-quantization). While this approach is intuitive and could be pushed far due to the exceptional properties of two-dimensional theories, it becomes cumbersome for some questions or even fails at a more fundamental level. These motivations have led to the development of SFT, a description of string theory using the field theory formalism (second-quantization). As a field theory, SFT provides a rigorous and constructive formulation of string theory. The main focus of the book is the construction of the closed bosonic SFT. The accent is put on providing the reader with the foundations, conceptual understanding and intuition of what SFT is. After reading this book, the reader is able to study the applications from the literature. The book is organized in two parts. The first part reviews the notions of the worldsheet theory that are necessary to build SFT (worldsheet path integral, CFT and BRST quantization). The second part starts by introducing general concepts of SFT from the BRST quantization. Then, it introduces off-shell string amplitudes before providing a Feynman diagrams interpretation from which the building blocks of SFT are extracted. After constructing the closed SFT, the author outlines the proofs of several important properties such as background independence, unitarity and crossing symmetry. Finally, the generalization to the superstring is also discussed.

Quantum Fields and Strings American Mathematical Soc.

This book contains an edited comprehensive collection of reprints on the subject of the large N limit as applied to a wide spectrum of problems in quantum field theory and statistical mechanics. The topics include (1) Spin Systems; (2) Large N Limit of Gauge Theories; (3) Two-Dimensional QCD; (4) Exact Results on Planar Perturbation Series and the Nature of the 1/N Series;

(5) Schwinger-Dyson Equations Approach; (6) QCD Phenomenological Lagrangians and the Large N Limit; (7) Other Approaches to Large N: Eguchi-Kawai Model, Collective Fields and Numerical Methods; (8) Matrix Models; (9) Two-Dimensional Gravity and String Theory.

Introduction to Strings and Branes World Scientific

This book contains exclusively invited contributions from collaborators of Maximilian Kreuzer, giving accounts of his scientific legacy and original articles from renowned theoretical physicists and mathematicians, including Victor Batyrev, Philip Candelas, Michael Douglas, Alexei Morozov, Joseph Polchinski, Peter van Nieuwenhuizen, and Peter West. Besides a collection of review and research articles from high-profile researchers in string theory and related fields of mathematics (in particular, algebraic geometry) which discuss recent progress in the exploration of string theory vacua and corresponding mathematical developments, this book contains a pedagogical account of the important work of Brandt, Dragon, and Kreuzer on classification of anomalies in gauge theories. This highly cited work, which is also quoted in the textbook of Steven Weinberg on quantum field theory, has not yet been presented in full detail except in private lecture notes by Norbert Dragon. Similarly, the software package PALP (Package for Analyzing Lattice Polytopes with applications to toric geometry), which has been incorporated in the SAGE (Software for Algebra and Geometry Experimentation) project, has not yet been documented in full detail. This book contains a user manual for a new thoroughly revised version of PALP. By including these two very useful original contributions, researchers in quantum field theory, string theory, and mathematics will find added value in a pedagogical presentation of the classification of quantum gauge field anomalies, and the accompanying comprehensive manual and tutorial for the powerful software package PALP.

Quantum Fields and Strings Cambridge University Press

During the past 15 years, quantum field theory and classical statistical mechanics have merged into a single field, and the need for nonperturbative methods for the description of critical phenomena in statistical mechanics as well as for problems in elementary particle physics are generally acknowledged. Such methods formed the central theme of the 1987 Cargese Advanced Study Institut. e on "Nonpert. urbat. ive Quantum Field Theory." The use of conformal symmet. ry has been of central interest in recent years, and was a main subject at. t. he ASI. Conformal invariant quantum field theory describes statistical mechanical systems exactly at a critical point, and can be analysed to a remarkable ext. ent. by group t. heoretical methods. Very strong results have been obtained for 2-dimensional systems. Conformal field theory is also the basis of string theory, which offers some hope of providing a unified t. heory of all interactions between elementary particles. Accordingly, a number of lectures and seminars were presented on these two topics. After syst. ematic introductory lectures, conformal field theory on Riemann surfaces, orbifolds, sigma models, and application of loop group theory and Grassmannians were discussed, and some ideas on modular geometry were presented. Other lectures combined' traditional techniques of constructive quant. um field theory with new methods such as the use of index-t. heorems and infinite dimensional (Kac Moody) symmetry groups. The problems encountered in a quantum mechanical description of black holes were discussed in detail.

Quantum Fields and Strings CRC Press

The essential beginner's guide to string theory The Little Book of String Theory offers a short, accessible, and entertaining introduction to one of the most talked-about areas of physics today. String theory has been called the "theory of everything." It seeks to describe all the fundamental forces of nature. It encompasses gravity and quantum mechanics in one unifying theory. But it is unproven and fraught with controversy. After reading this book, you'll be able to draw your own conclusions about string theory. Steve Gubser begins by explaining Einstein's famous equation E = mc2, quantum mechanics, and black holes. He then gives readers a crash course in string theory and the core ideas behind it. In plain English and with a minimum of mathematics, Gubser covers strings, branes, string dualities, extra dimensions, curved spacetime, quantum fluctuations, symmetry, and supersymmetry. He describes efforts to link string theory to experimental physics and uses analogies that nonscientists can understand. How does Chopin's Fantasie-Impromptu relate to quantum mechanics? What would it be like to fall into a black hole? Why is dancing a waltz similar to contemplating a string duality? Find out in the pages of this book. The Little Book of String Theory is the essential, most up-to-date beginner's guide to this elegant, multidimensional field of physics.

A Course for Mathematicians American Mathematical Soc.

This book takes a pedagogical approach to explaining quantum gravity, supersymmetry and string theory in a coherent way. It is aimed at graduate students and researchers in quantum field theory and high-energy physics. The first part of the book introduces quantum gravity, without requiring previous knowledge of general relativity (GR). The necessary geometrical aspects are derived afresh leading to explicit general Lagrangians for gravity, including that of general relativity. The quantum aspect of gravitation, as described by the graviton, is introduced and perturbative quantum GR is discussed. The Schwinger-DeWitt formalism is developed to compute the one-loop contribution to the theory and renormalizability aspects of the perturbative theory are also discussed. This follows by introducing only the very basics of a non-perturbative, background-independent, formulation of quantum gravity, referred to as “loop quantum gravity”, which gives rise to a quantization of space. In the second part the author introduces supersymmetry and its consequences. The generation of superfields is represented in detail. Supersymmetric generalizations of Maxwell’s Theory as well as of Yang-Mills field theory, and of the standard model are worked out. Spontaneous symmetry breaking, improvement of the divergence problem in supersymmetric field theory, and its role in the hierarchy problem are covered. The unification of the fundamental constants in a supersymmetric version of the standard model are then studied. Geometrical aspects necessary to study supergravity are developed culminating in the derivation of its full action. The third part introduces string theory and the analysis of the spectra of the mass (squared) operator associated with the oscillating strings. The properties of the underlying fields, associated with massless particles, encountered in string theory are studied in some detail. Elements of compactification, duality and D-branes are given, as well of the generation of vertices and interactions of strings. In the final sections, the author shows how to recover GR and the Yang-Mills field Theory from string theory.

The Legacy of Maximilian Kreuzer

Springer

The past two decades have seen transformative advances in cosmology and string theory. Observations of the cosmic microwave background have revealed strong evidence for inflationary expansion in the very early universe, while new insights about compactifications of string theory have led to a deeper understanding of inflation in a framework that unifies quantum mechanics and general relativity. Written by two of the leading researchers in the field, this complete and accessible volume provides a modern treatment of inflationary cosmology and its connections to string theory and elementary particle theory. After an up-to-date experimental summary, the authors present the foundations of effective field theory, string theory, and string compactifications, setting the stage for a detailed examination of models of inflation in string theory. Three appendices contain background material in geometry and cosmological perturbation theory, making this a self-contained resource for graduate students and researchers in string theory, cosmology, and related fields.

An Introduction To Quantum Field Theory

Cambridge University Press

This book takes a pedagogical approach to explaining quantum gravity, supersymmetry and string theory in a coherent way. It is aimed at graduate students and researchers in quantum field theory and high-energy physics. The first part of the book introduces quantum gravity, without requiring previous knowledge of general relativity (GR). The necessary geometrical aspects are derived afresh leading to explicit general Lagrangians for gravity, including that of general relativity. The quantum aspect of gravitation, as described by the graviton, is introduced and perturbative quantum GR is discussed. The Schwinger-DeWitt formalism is developed to compute the one-loop contribution to the theory and renormalizability aspects of the perturbative theory are also discussed. This follows by introducing only the very basics of a non-perturbative, background-independent, formulation of quantum gravity, referred to as “loop quantum gravity”, which gives rise to a quantization of space. In the second part the author introduces supersymmetry and its consequences. The generation of superfields is represented in detail. Supersymmetric generalizations of Maxwell’s Theory as well as of Yang-Mills field theory, and of the standard model are worked out. Spontaneous symmetry breaking, improvement of the divergence problem in supersymmetric field theory, and its role in the hierarchy problem are covered. The unification of the fundamental constants in a supersymmetric version of the standard model are then studied. Geometrical aspects necessary to study supergravity are developed culminating in the derivation of its full action. The third part introduces string theory and the analysis of the spectra of the mass (squared) operator associated with the oscillating strings. The properties of the underlying fields, associated with massless particles, encountered in string theory are studied in some detail. Elements of compactification, duality and D-branes are given, as well of the generation of vertices and interactions of strings. In the final sections, the author shows how to recover GR and the Yang-Mills field Theory from string theory.

Differential Topology and Quantum Field Theory Quantum Fields and StringsA Course for Mathematicians

An Introduction to Quantum Field Theory is a textbook intended for the graduate physics course covering relativistic quantum mechanics, quantum electrodynamics, and Feynman diagrams. The authors make these subjects accessible through carefully worked examples illustrating the technical aspects of the subject, and intuitive explanations of what is going on behind the mathematics. After presenting the basics of quantum electrodynamics, the authors discuss the theory of renormalization and its relation to statistical mechanics, and introduce the renormalization group. This discussion sets the stage for a discussion of the physical principles that underlie the fundamental interactions of elementary particle physics and their description by gauge field theories.

A Course for Mathematicians Oxford University Press

This is the first comprehensive presentation of the quantum non-linear sigma-models. The original papers consider in detail geometrical properties and renormalization of a generic non-linear sigma-model, illustrated by explicit multi-loop calculations in perturbation theory.

Inflation and String Theory Springer

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Aspects of Quantum Fields and Strings on AdS Black Holes CRC Press

Ideas from quantum field theory and string theory have had considerable impact on mathematics over the past 20 years. Advances in many different areas have been inspired by insights from physics. In 1996-97 the Institute for Advanced Study (Princeton, NJ) organized a special year-long program designed to teach mathematicians the basic physical ideas which underlie the mathematical applications. The purpose is eloquently stated in a letter written by Robert MacPherson: ``The goal is to create and convey an understanding, in terms congenial to mathematicians, of some fundamental notions of physics ... [and to] develop the sort of intuition common among physicists for those who are used to thought processes stemming from geometry and algebra.'' These volumes are a written record of the program. They contain notes from several long and many short courses covering various aspects of quantum field theory and perturbative string theory. The courses were given by leading physicists and the notes were written either by the speakers or by mathematicians who participated in the program. The book also includes problems and solutions worked out by the editors and other leading participants. Interspersed are mathematical texts with background material and commentary on some topics covered in the lectures. These two volumes present the first truly comprehensive introduction to this field aimed at a mathematics audience. They offer a unique opportunity for mathematicians and mathematical physicists to learn about the beautiful and difficult subjects of quantum field theory and string theory.

A Modern Introduction with Exercises
Cambridge University Press

This book introduces two-dimensional supersymmetric field theories with emphasis on both linear and non-linear sigma models. Complex differential geometry, in connection with supersymmetry, has played a key role in most developments of the last thirty years in quantum field theory and string theory. Both structures introduce a great deal of rigidity compared to the more general categories of non-supersymmetric theories and real differential geometry, allowing for many general conceptual results and detailed quantitative predictions. Two-dimensional (0,2) supersymmetric quantum field theories provide a natural arena for the fruitful interplay between geometry and quantum field theory. These theories play an important role in string theory and provide generalizations, still to be explored fully, of rich structures such as mirror symmetry. They also have applications to non-perturbative four-dimensional physics, for instance as descriptions of surface defects or low energy dynamics of solitonic strings in four-dimensional supersymmetric theories. The purpose of these lecture notes is to acquaint the reader with these fascinating theories, assuming a background in conformal theory, quantum field theory and differential geometry at the beginning graduate level. In order to investigate the profound relations between structures from complex geometry and field theory the text begins with a thorough examination of the basic structures of (0,2) quantum field theory and conformal field theory. Next, a simple class of Lagrangian theories, the (0,2) Landau-Ginzburg models, are discussed, together with the resulting renormalization group flows, dynamics, and symmetries. After a thorough introduction and examination of (0,2) non-linear sigma models, the text introduces linear sigma models that, in particular, provide a unified treatment of non-linear sigma models and Landau-Ginzburg theories. Many exercises, along with discussions of relevant mathematical notions and important open problems in the field, are included in the text.

Introductions to Quantum Gravity, Supersymmetry and String Theory
American Mathematical Soc.

Quantum field theory provides the theoretical backbone to most modern physics. This book is designed to bring quantum field theory to a wider audience of physicists. It is packed with worked examples, witty diagrams, and applications intended to introduce a new audience to this revolutionary theory.

An Introduction to Two-Dimensional Quantum Field Theory with (0,2) Supersymmetry American Mathematical Soc.

Ideas from quantum field theory and string theory have had considerable impact on mathematics over the past 20 years. Advances in many different areas have been inspired by insights from physics. In 1996-97 the Institute for Advanced Study (Princeton, NJ) organized a special year-long program designed to teach mathematicians the basic physical ideas which underlie the mathematical applications. The purpose is eloquently stated in a letter written by Robert MacPherson: ``The goal is to create and convey an understanding, in terms congenial to mathematicians, of some fundamental notions of physics ... [and to] develop the sort of intuition common among physicists for those who are used to thought processes stemming from geometry and algebra.'' These volumes are a written record of the program. They contain notes from several long and many short courses covering various aspects of quantum field theory and perturbative string theory. The courses were given by leading physicists and the notes were written either by the speakers or by mathematicians who participated in the program. The book also includes problems and solutions worked out by the editors and other leading participants. Interspersed are mathematical texts with background material and commentary on some topics covered in the lectures. These two volumes present the first truly comprehensive introduction to this field aimed at a mathematics audience. They offer a unique opportunity for mathematicians and mathematical physicists to learn about the beautiful and difficult subjects of quantum field theory and string theory.

A Course for Mathematicians World Scientific

Based on his own work, the author synthesizes the most promising approaches and ideals in field theory today. He presents such subjects as statistical mechanics, quantum field theory and their interrelation, continuous global symmetry, non-Abelian gauge fields, instantons and the quantam theory of loops, and quantum strings and random surfaces. This book is aimed at postgraduate students studying field theory and statistical mechanics, and for research workers in continuous global theory.

String Field Theory Cambridge University Press

Ideas from quantum field theory and string theory have had considerable impact on mathematics since the 1980s. Advances in many different areas have been inspired by insights from physics. In 1996-97 the Institute for Advanced Study (Princeton, NJ) organized a special year-long programme designed to teach mathematicians the basic physical ideas which underlie the mathematical applications.