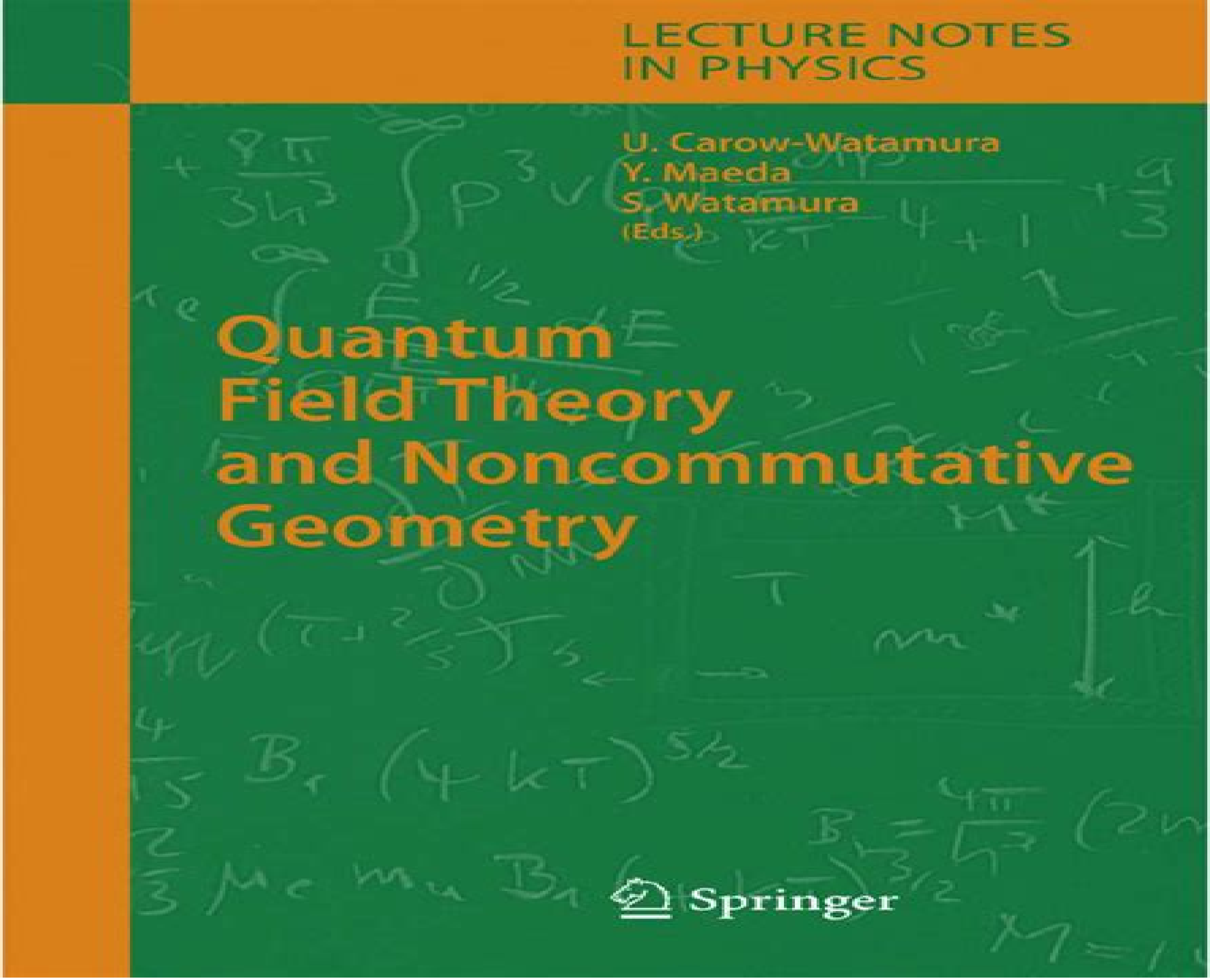

LECTURE NOTES
IN PHYSICS

U. Carow-Watamura
Y. Maeda
S. Watamura
(Eds.)

# Quantum Field Theory and Noncommutative Geometry

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# Quantum Field Theory And Noncommutative Geometry

**Cécile Dewitt-Morette,Jean-Bernard Zuber**

**Quantum Field Theory And Noncommutative Geometry:**

**Structural Aspects Of Quantum Field Theory And Noncommutative Geometry (Second Edition) (In 2 Volumes)** Gerhard Grensing,2021-07-15 The book is devoted to the subject of quantum field theory It is divided into two volumes The first volume can serve as a textbook on main techniques and results of quantum field theory while the second treats more recent developments in particular the subject of quantum groups and noncommutative geometry and their interrelation The second edition is extended by additional material mostly concerning the impact of noncommutative geometry on theories beyond the standard model of particle physics especially the possible role of torsion in the context of the dark matter problem Furthermore the text includes a discussion of the Randall Sundrum model and the Seiberg Witten equations

Quantum Field Theory and Noncommutative Geometry Ursula Carow-Watamura,Yoshiaki Maeda,2005-02-21 This volume reflects the growing collaboration between mathematicians and theoretical physicists to treat the foundations of quantum field theory using the mathematical tools of q deformed algebras and noncommutative differential geometry A particular challenge is posed by gravity which probably necessitates extension of these methods to geometries with minimum length and therefore quantization of space This volume builds on the lectures and talks that have been given at a recent meeting on Quantum Field Theory and Noncommutative Geometry A considerable effort has been invested in making the contributions accessible to a wider community of readers so this volume will not only benefit researchers in the field but also postgraduate students and scientists from related areas wishing to become better acquainted with this field Structural Aspects of Quantum Field Theory [and Noncommutative Geometry]: Structural aspects of quantum field theory and noncommutative geometry Gerhard Grensing,World Scientific (Singapur).,2013 **Structural Aspects Of Quantum Field Theory (In 2 Volumes)** Gerhard Grensing,2013-05-21 The book is primarily addressed to physicists Nevertheless as numerous examples are known in which exploration of the land where physics and mathematics overlap and which quantum field theory definitely belongs to resulted in important developments in mathematics many mathematicians may also find this book interesting and even inspiring MathSciNetThis book is devoted to the subject of quantum field theory It is divided into two volumes The first can serve as a textbook on the main techniques and results of quantum field theory while the second treats more recent developments in particular the subject of quantum groups and noncommutative geometry and their interrelation The first volume is directed at graduate students who want to learn the basic facts about quantum field theory It begins with a gentle introduction to classical field theory including the standard model of particle physics general relativity and also supergravity The transition to quantized fields is performed with path integral techniques by means of which the one loop renormalization of a self interacting scalar quantum field of quantum electrodynamics and the asymptotic freedom of quantum chromodynamics is treated In the last part of the first volume the application of path integral methods to systems of quantum statistical mechanics is covered The book ends with a rather detailed investigation of the fractional quantum Hall effect and gives a stringent derivation of Laughlin s trial ground state wave function as an exact ground state The second volume covers more advanced themes In particular Connes noncommutative geometry is dealt with in some considerable detail the presentation attempts to acquaint the physics community with the substantial achievements that have been reached by means of this approach towards the understanding of the elusive Higgs particle The book also covers the subject of quantum groups and its application to the fractional quantum Hall effect as it is for this paradigmatic physical system that noncommutative geometry and quantum groups can be brought together **Noncommutative Geometry, Quantum Fields and Motives** Alain Connes,Matilde Marcolli, This book carries the unifying theme of the interaction among noncommutative geometry theoretical physics and number theory The detailed text co authored by Fields Medal winner Alain Connes stresses the relevance of noncommutative geometry in dealing with two spaces space time and the space of prime numbers The book includes significantly more detail than other monographs covering similar topics *Noncommutative Geometry and Quantum Field Theory* ,2005 Noncommutative Structures in Mathematics and Physics Steven Duplij,Julius Wess,2001-05-31 A presentation of outstanding achievements and ideas of both eastern and western scientists both mathematicians and physicists Their presentations of recent work on quantum field theory supergravity M theory black holes and quantum gravity together with research into noncommutative geometry Hopf algebras representation theory categories and quantum groups take the reader to the forefront of the latest developments Other topics covered include supergravity and branes supersymmetric quantum mechanics and superparticles super black holes superalgebra representations and SUSY GUT phenomenology Essential reading for workers in the modern methods of theoretical and mathematical physics

*K-theory and Noncommutative Geometry* Guillermo Cortiñas,2008 Since its inception 50 years ago K theory has been a tool for understanding a wide ranging family of mathematical structures and their invariants topological spaces rings algebraic varieties and operator algebras are the dominant examples The invariants range from characteristic classes in cohomology determinants of matrices Chow groups of varieties as well as traces and indices of elliptic operators Thus K theory is notable for its connections with other branches of mathematics Noncommutative geometry develops tools which allow one to think of noncommutative algebras in the same footing as commutative ones as algebras of functions on noncommutative spaces The algebras in question come from problems in various areas of mathematics and mathematical physics typical examples include algebras of pseudodifferential operators group algebras and other algebras arising from quantum field theory To study noncommutative geometric problems one considers invariants of the relevant noncommutative algebras These invariants include algebraic and topological K theory and also cyclic homology discovered independently by Alain Connes and Boris Tsygan which can be regarded both as a noncommutative version of de Rham cohomology and as an additive version of K theory There are primary and secondary Chern characters which pass from K theory to cyclic homology These characters are relevant both to noncommutative and commutative problems and have applications ranging from index theorems to the detection of singularities of commutative algebraic varieties The contributions to this volume represent this range of connections between K theory noncommmutative geometry and other branches of mathematics **An Invitation to Noncommutative Geometry** Masoud Khalkhali,Matilde Marcolli,2008 This is the first existing volume that collects lectures on this important and fast developing subject in mathematics The lectures are given by leading experts in the field and the range of topics is kept as broad as possible by including both the algebraic and the differential aspects of noncommutative geometry as well as recent applications to theoretical physics and number theory *Quantum Field Theory: Perspective and Prospective* Cécile Dewitt-Morette,Jean-Bernard Zuber,2012-12-06 It has been said that String theorists talk to string theorists and everyone else wonders what they are saying This book will be a great help to those researchers who are challenged by modern quantum field theory Quantum field theory experienced a renaissance in the late 1960s Here participants in the Les Houches sessions of 1970 75 now key players in quantum field theory and its many impacts assess developments in their field of interest and provide guidance to young researchers challenged by these developments but overwhelmed by their complexities The book is not a textbook on string theory rather it is a complement to Polchinski s book on string theory It is a survey of current problems which have their origin in quantum field theory On Finite 4D Quantum Field Theory in Non-commutative Geometry H. Grosse,C. Klimčík,P. Prešnajder,1996 **Quantization, Geometry and Noncommutative Structures in Mathematics and Physics** Alexander Cardona,Pedro Morales,Hernán Ocampo,Sylvie Paycha,Andrés F. Reyes Lega,2017-10-26 This monograph presents various ongoing approaches to the vast topic of quantization which is the process of forming a quantum mechanical system starting from a classical one and discusses their numerous fruitful interactions with mathematics The opening chapter introduces the various forms of quantization and their interactions with each other and with mathematics A first approach to quantization called deformation quantization consists of viewing the Planck constant as a small parameter This approach provides a deformation of the structure of the algebra of classical observables rather than a radical change in the nature of the observables When symmetries come into play deformation quantization needs to be merged with group actions which is presented in chapter 2 by Simone Gutt The noncommutativity arising from quantization is the main concern of noncommutative geometry Allowing for the presence of symmetries requires working with principal fiber bundles in a non commutative setup where Hopf algebras appear naturally This is the topic of chapter 3 by Christian Kassel Nichols algebras a special type of Hopf algebras are the subject of chapter 4 by Nicol s Andruskiewitsch The purely algebraic approaches given in the previous chapters do not take the geometry of space time into account For this purpose a special treatment using a more geometric point of view is required An approach to field quantization on curved space time with applications to cosmology is presented in chapter 5 in an account of the lectures of Abhay Ashtekar that brings a complementary point of view to non commutativity An alternative quantization procedure is known under the name of string theory In chapter 6 its supersymmetric version is presented Superstrings have drawn the attention of many mathematicians due to its various fruitful interactions with algebraic geometry some of which are described here The remaining chapters discuss further topics as the Batalin Vilkovisky formalism and direct products of spectral triples This volume addresses both physicists and mathematicians and serves as an introduction to ongoing research in very active areas of mathematics and physics at the border line between geometry topology algebra and quantum field theory **Geometric and Topological Methods for Quantum Field Theory** Hernan Ocampo,Sylvie Paycha,Andrés Vargas,2005-06-13 This volume offers an introduction in the form of four extensive lectures to some recent developments in several active topics at the interface between geometry topology and quantum field theory The first lecture is by Christine Lescop on knot invariants and configuration spaces in which a universal finite type invariant for knots is constructed as a series of integrals over configuration spaces This is followed by the contribution of Raimar Wulkenhaar on Euclidean quantum field theory from a statistical point of view The author also discusses possible renormalization techniques on noncommutative spaces The third lecture is by Anamaria Font and Stefan Theisen on string compactification with unbroken supersymmetry The authors show that this requirement leads to internal spaces of special holonomy and describe Calabi Yau manifolds in detail The last lecture by Thierry Fack is devoted to a K theory proof of the Atiyah Singer index theorem and discusses some applications of K theory to noncommutative geometry These lectures notes which are aimed in particular at graduate students in physics and mathematics start with introductory material before presenting more advanced results Each chapter is self contained and can be read independently Geometric and Topological Methods for Quantum Field Theory Hernan Ocampo,Sylvie Paycha,Andrés Vargas,2009-09-02 This volume offers an introduction in the form of four extensive lectures to some recent developments in several active topics at the interface between geometry topology and quantum field theory The first lecture is by 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contained and can be read independently **Noncommutative Geometry And Physics 4 - Workshop On Strings, Membranes And Topological Field Theory** Yoshiaki Maeda,Hitoshi Moriyoshi,Motoko Kotani,Satoshi Watamura,2017-03-16 This book is a collection of the lectures and talks presented in the Tohoku Forum for Creativity in the thematic year 2015 Fundamental

Problems in Quantum Physics Strings Black Holes and Quantum Information and related events in the period 2014 2016 This volume especially contains an overview of recent developments in the theory of strings and membranes as well as topological field theory Quantum and Non-Commutative Analysis Huzihiro Araki,Keiichi R. Ito,Akitaka Kishimoto,Izumi Ojima,2013-04-17 In the past decade there has been a sudden and vigorous development in a number of research areas in mathematics and mathematical physics such as theory of operator algebras knot theory theory of manifolds infinite dimensional Lie algebras and quantum groups as a new topics etc on the side of mathematics quantum field theory and statistical mechanics on the side of mathematical physics The new development is characterized by very strong relations and interactions between different research areas which were hitherto considered as remotely related Focussing on these new developments in mathematical physics and theory of operator algebras the International Oji Seminar on Quantum Analysis was held at the Kansai Seminar House Kyoto JAPAN during June 25 29 1992 by a generous sponsorship of the Japan Society for the Promotion of Science and the Fujihara Foundation of Science as a workshop of relatively small number of about 50 invited participants This was followed by an open Symposium at RIMS described below by its organizer A Kishimoto The Oji Seminar began with two key note addresses one by V F R Jones on Spin Models in Knot Theory and von Neumann Algebras and by A Jaffe on Where Quantum Field Theory Has Led Subsequently topics such as Subfactors and Sector Theory Solvable Models of Statistical Mechanics Quantum Field Theory Quantum Groups and Renormalization Group Ap proach are discussed Towards the end a panel discussion on Where Should Quantum Analysis Go was held Geometric And Topological Methods For Quantum Field Theory - Proceedings Of The Summer School Alexander Cardona,Hernan Ocampo,Sylvie Paycha,2003-03-21 This volume offers an introduction to recent developments in several active topics of research at the interface between geometry topology and quantum field theory These include Hopf algebras underlying renormalization schemes in quantum field theory noncommutative geometry with applications to index theory on one hand and the study of aperiodic solids on the other geometry and topology of low dimensional manifolds with applications to topological field theory Chern Simons supergravity and the anti de Sitter conformal field theory correspondence It comprises seven lectures organized around three main topics noncommutative geometry topological field theory followed by supergravity and string theory complemented by some short communications by young participants of the school *Perspectives on Noncommutative Geometry* Masoud Khalkhali,2011 This volume represents the proceedings of the Noncommutative Geometry Workshop that was held as part of the thematic program on operator algebras at the Fields Institute in May 2008 Pioneered by Alain Connes starting in the late 1970s noncommutative geometry was originally inspired by global analysis topology operator algebras and quantum physics Its main applications were to settle some long standing conjectures such as the Novikov conjecture and the Baum Connes conjecture Next came the impact of spectral geometry and the way the spectrum of a geometric operator like the Laplacian holds information about the geometry and topology of a manifold as in the celebrated Weyl law This has now been vastly generalized through Connes notion of spectral triples Finally recent years have witnessed the impact of number theory algebraic geometry and the theory of motives and quantum field theory on noncommutative geometry Almost all of these aspects are touched upon with new results in the papers of this volume This book is intended for graduate students and researchers in both mathematics and theoretical physics who are interested in noncommutative geometry and its applications *Geometry, Topology and Quantum Field Theory* P. Bandyopadhyay,2014-03-14 This is a monograph on geometrical and topological features which arise in quantum field theory It is well known that when a chiral fermion interacts with a gauge field we have chiral anomaly which corresponds to the fact that divergence of the axial vector current does not vanish It is observed that this is related to certain topological features associated with the fermion and leads to the realization of the topological origin of fermion number as well as the Berry phase The role of gauge fields in the quantization procedure has its implications in these topological features of a fermion and helps us to consider a massive fermion as a soliton skyrrnion In this formalism chiral anomaly is found to be responsible for mass generation This has its relevance in electroweak theory where it is observed that weak interaction gauge bosons attain mass topologically The geometrical feature of a skyrmion also helps us to realize the internal symmetry of hadrons from reflection group Finally it has been shown that noncommutative geometry where the space time manifold is taken to be X M x Zz has its relevance in the description of a massive 4 fermion as a skyrmion when the discrete space is considered as the internal space and the symmetry breaking leads to chiral anomaly In chap l preliminary mathematical formulations related to the spinor structure have been discussed In chap Non-commutative Geometry Supriya Kar,2018-01-31 This book provides a systematic comprehensive and up to date account of the recent developments in non commutative geometry at a pedagogical level It does not go into the details of rigorous advanced level mathematical formulation of non commutative geometry rather it restricts itself to the domain of strings and quantum fields Since non commutative geometry has recently aroused renewed interest in open string theory the author motivates the text from the viewpoint of a string theory He begins with an introduction to the subject explaining what one means by non commutative geometry and why it is relevant to study such geometry and discussing its possible origin in a string theory The book comprises nine chapters Chapter 1 gives a sound mathematical ntroduction to non commutative spacetime coordinates in classical and quantum physics In Chapter 2 non commutativity in a string theory is discussed at a pedagogic level Chapter 3 deals with an aribitrary D brane dynamics and Chapter 4 describes the non commutative gauge theories on a D brane In Chapters 5 9 non commutative quantum field theory NCQFT is addressed In particular Chapter 5 deals with the real scalar NCQFT Chapter 6 with that of complex scalar field Chapter 7 describes spontaneous symmetry breaking in scalar NCQFT Chapter 8 deals with the U 1 Gauge theory and Chapter 9 with SU n Gauge theories Students will find this book useful as a bridge between string and field theories In addition it will prove invaluable for interdisciplinary areas of study

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