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Noncommutative Geometry and the Standard Model of Elementary Particle Physics



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Noncommutative Geometry And The Standard Model Of Elementary Particle Physics

Alain Connes, Matilde Marcolli



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Noncommutative Geometry and the Standard Model of Elementary Particle Physics Florian Scheck, Wend Werner, Harald Upmeyer, 2008-01-11 The outcome of a close collaboration between mathematicians and mathematical physicists these lecture notes present the foundations of A Connes noncommutative geometry as well as its applications in particular to the field of theoretical particle physics The coherent and systematic approach makes this book useful for experienced researchers and postgraduate students alike *Noncommutative Geometry and the Standard Model of Elementary Particle Physics* Florian Scheck, Wend Werner, Harald Upmeyer, 2002-11-26 The outcome of a close collaboration between mathematicians and mathematical physicists these Lecture Notes present the foundations of A Connes noncommutative geometry as well as its applications in particular to the field of theoretical particle physics The coherent and systematic approach makes this book useful for experienced researchers and postgraduate students alike

Noncommutative Geometry and Particle Physics Walter D. van Suijlekom, 2014-07-21 This book provides an introduction to noncommutative geometry and presents a number of its recent applications to particle physics It is intended for graduate students in mathematics theoretical physics who are new to the field of noncommutative geometry as well as for researchers in mathematics theoretical physics with an interest in the physical applications of noncommutative geometry In the first part we introduce the main concepts and techniques by studying finite noncommutative spaces providing a light approach to noncommutative geometry We then proceed with the general framework by defining and analyzing noncommutative spin manifolds and deriving some main results on them such as the local index formula In the second part we show how noncommutative spin manifolds naturally give rise to gauge theories applying this principle to specific examples We subsequently geometrically derive abelian and non abelian Yang Mills gauge theories and eventually the full Standard Model of particle physics and conclude by explaining how noncommutative geometry might indicate how to proceed beyond the Standard Model *Noncommutative Geometry and Particle Physics* Walter van Suijlekom, 2014-07-27 This book provides an introduction to noncommutative geometry and presents a number of its recent applications to particle physics It is intended for graduate students in mathematics theoretical physics who are new to the field of noncommutative geometry as well as for researchers in mathematics theoretical physics with an interest in the physical applications of noncommutative geometry In the first part we introduce the main concepts and techniques by studying finite noncommutative spaces providing a light approach to noncommutative geometry We then proceed with the general framework by defining and analyzing noncommutative spin manifolds and deriving some main results on them such as the local index formula In the second part we show how noncommutative spin manifolds naturally give rise to gauge theories applying this principle to specific examples We subsequently geometrically derive abelian and non abelian Yang Mills gauge theories and eventually the full Standard Model of particle physics and conclude by explaining how noncommutative geometry might indicate how to proceed

beyond the Standard Model **Advances in Noncommutative Geometry** Ali Chamseddine, Caterina Consani, Nigel Higson, Masoud Khalkhali, Henri Moscovici, Guoliang Yu, 2020-01-13 This authoritative volume in honor of Alain Connes the foremost architect of Noncommutative Geometry presents the state of the art in the subject The book features an amalgam of invited survey and research papers that will no doubt be accessed read and referred to for several decades to come The pertinence and potency of new concepts and methods are concretely illustrated in each contribution Much of the content is a direct outgrowth of the Noncommutative Geometry conference held March 23 April 7 2017 in Shanghai China The conference covered the latest research and future areas of potential exploration surrounding topology and physics number theory as well as index theory and its ramifications in geometry **An Invitation to Noncommutative Geometry** Masoud Khalkhali, Matilde Marcolli, 2008 A walk in the noncommutative garden A Connes and M Marcolli Renormalization of noncommutative quantum field theory H Grosse and R Wulkenhaar Lectures on noncommutative geometry M Khalkhali Noncommutative bundles and instantons in Tehran G Landi and W D van Suijlekom Lecture notes on noncommutative algebraic geometry and noncommutative tori S Mahanta Lectures on derived and triangulated categories B Noohi Examples of noncommutative manifolds complex tori and spherical manifolds J Plazas D branes in noncommutative field theory R J Szabo **Quantum Field Theory III: Gauge Theory** Eberhard Zeidler, 2011-08-17 In this third volume of his modern introduction to quantum field theory Eberhard Zeidler examines the mathematical and physical aspects of gauge theory as a principle tool for describing the four fundamental forces which act in the universe gravitative electromagnetic weak interaction and strong interaction Volume III concentrates on the classical aspects of gauge theory describing the four fundamental forces by the curvature of appropriate fiber bundles This must be supplemented by the crucial but elusive quantization procedure The book is arranged in four sections devoted to realizing the universal principle force equals curvature Part I The Euclidean Manifold as a Paradigm Part II Ariadne s Thread in Gauge Theory Part III Einstein s Theory of Special Relativity Part IV Ariadne s Thread in Cohomology For students of mathematics the book is designed to demonstrate that detailed knowledge of the physical background helps to reveal interesting interrelationships among diverse mathematical topics Physics students will be exposed to a fairly advanced mathematics beyond the level covered in the typical physics curriculum Quantum Field Theory builds a bridge between mathematicians and physicists based on challenging questions about the fundamental forces in the universe macrocosmos and in the world of elementary particles microcosmos Poisson Geometry in Mathematics and Physics Giuseppe Dito, 2008 This volume is a collection of articles by speakers at the Poisson 2006 conference The program for Poisson 2006 was an overlap of topics that included deformation quantization generalized complex structures differentiable stacks normal forms and group valued moment maps and reduction Singular Traces Steven Lord, Fedor Sukochev, Dmitriy Zanin, 2012-12-19 This book is the first complete study and monograph dedicated to singular traces The text mathematically formalises the study of traces in a self contained theory

of functional analysis Extensive notes will treat the historical development The final section will contain the most complete and concise treatment known of the integration half of Connes quantum calculus Singular traces are traces on ideals of compact operators that vanish on the subideal of finite rank operators Singular traces feature in A Connes interpretation of noncommutative residues Particularly the Dixmier trace which generalises the restricted Adler Manin Wodzicki residue of pseudo differential operators and plays the role of the residue for a new catalogue of geometric spaces including Connes Chamseddine standard models Yang Mills action for quantum differential forms fractals isospectral deformations foliations and noncommutative index theory The theory of singular traces has been studied after Connes application to non commutative geometry and physics by various authors Recent work by Nigel Kalton and the authors has advanced the theory of singular traces Singular traces can be equated to symmetric functionals of symmetric sequence or function spaces residues of zeta functions and heat kernel asymptotics and characterised by Lidksii and Fredholm formulas The traces and formulas used in noncommutative geometry are now completely understood in this theory with surprising new mathematical and physical consequences For mathematical readers the text offers fundamental functional analysis results and due to Nigel Kalton s contribution a now complete theory of traces on compact operators For mathematical physicists and other users of Connes noncommutative geometry the text offers a complete reference to Dixmier traces and access to the deeper mathematical features of traces on ideals associated to the harmonic sequence These features not known and not discussed in general texts on noncommutative geometry are undoubtedly physical and probe to the fascinating heart of classical limits and quantization

Noncommutative Geometry Alain Connes,1995-01-17 This English version of the path breaking French book on this subject gives the definitive treatment of the revolutionary approach to measure theory geometry and mathematical physics developed by Alain Connes Profusely illustrated and invitingly written this book is ideal for anyone who wants to know what noncommutative geometry is what it can do or how it can be used in various areas of mathematics quantization and elementary particles and fields First full treatment of the subject and its applications Written by the pioneer of this field Broad applications in mathematics Of interest across most fields Ideal as an introduction and survey Examples treated include the space of Penrose tilings the space of leaves of a foliation the space of irreducible unitary representations of a discrete group the phase space in quantum mechanics the Brillouin zone in the quantum Hall effect A model of space time

Noncommutative Geometry, Quantum Fields and Motives Alain Connes,Matilde Marcolli,2019-03-13 The unifying theme of this book is the interplay among noncommutative geometry physics and number theory The two main objects of investigation are spaces where both the noncommutative and the motivic aspects come to play a role space time where the guiding principle is the problem of developing a quantum theory of gravity and the space of primes where one can regard the Riemann Hypothesis as a long standing problem motivating the development of new geometric tools The book stresses the relevance of noncommutative geometry in dealing with these two spaces The first part of the book deals with quantum field

theory and the geometric structure of renormalization as a Riemann Hilbert correspondence It also presents a model of elementary particle physics based on noncommutative geometry The main result is a complete derivation of the full Standard Model Lagrangian from a very simple mathematical input Other topics covered in the first part of the book are a noncommutative geometry model of dimensional regularization and its role in anomaly computations and a brief introduction to motives and their conjectural relation to quantum field theory The second part of the book gives an interpretation of the Weil explicit formula as a trace formula and a spectral realization of the zeros of the Riemann zeta function This is based on the noncommutative geometry of the ad le class space which is also described as the space of commensurability classes of \mathbb{Q} lattices and is dual to a noncommutative motive endomotive whose cyclic homology provides a general setting for spectral realizations of zeros of L functions The quantum statistical mechanics of the space of \mathbb{Q} lattices in one and two dimensions exhibits spontaneous symmetry breaking In the low temperature regime the equilibrium states of the corresponding systems are related to points of classical moduli spaces and the symmetries to the class field theory of the field of rational numbers and of imaginary quadratic fields as well as to the automorphisms of the field of modular functions The book ends with a set of analogies between the noncommutative geometries underlying the mathematical formulation of the Standard Model minimally coupled to gravity and the moduli spaces of \mathbb{Q} lattices used in the study of the zeta function

Geometric Methods For Quantum Field Theory Hernan Ocampo,Sylvie Paycha,Andres F Reyes-lega,2001-04-30 Both mathematics and mathematical physics have many active areas of research where the interplay between geometry and quantum field theory has proved extremely fruitful Duality gauge field theory geometric quantization Seiberg Witten theory spectral properties and families of Dirac operators and the geometry of loop groups offer some striking recent examples of modern topics which stand on the borderline between geometry and analysis on the one hand and quantum field theory on the other where the physicist s and the mathematician s perspective complement each other leading to new mathematical and physical concepts and results This volume introduces the reader to some basic mathematical and physical tools and methods required to follow the recent developments in some active areas of mathematical physics including duality gauge field theory geometric quantization Seiberg Witten theory spectral properties and families of Dirac operators and the geometry of loop groups It comprises seven self contained lectures which should progressively give the reader a precise idea of some of the techniques used in these areas as well as a few short communications presented by young participants at the school

Theory Steven Lord,Fedor Sukochev,Dmitriy Zanin,2021-07-19 This book is the second edition of the first complete study and monograph dedicated to singular traces The text offers due to the contributions of Albrecht Pietsch and Nigel Kalton a complete theory of traces and their spectral properties on ideals of compact operators on a separable Hilbert space The second edition has been updated on the fundamental approach provided by Albrecht Pietsch For mathematical physicists and other users of Connes noncommutative geometry the text offers a complete reference to traces on weak trace class operators

including Dixmier traces and associated formulas involving residues of spectral zeta functions and asymptotics of partition functions

Quantum Field Theory I: Basics in Mathematics and Physics Eberhard Zeidler, 2007-04-18 This is the first volume of a modern introduction to quantum field theory which addresses both mathematicians and physicists at levels ranging from advanced undergraduate students to professional scientists The book bridges the acknowledged gap between the different languages used by mathematicians and physicists For students of mathematics the author shows that detailed knowledge of the physical background helps to motivate the mathematical subjects and to discover interesting interrelationships between quite different mathematical topics For students of physics fairly advanced mathematics is presented which goes beyond the usual curriculum in physics

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

Trace Formulas Steven Lord, Edward McDonald, Fedor

Sukochev, Dmitriy Zanin, 2023-04-03 This volume introduces noncommutative integration theory on semifinite von Neumann algebras and the theory of singular traces for symmetric operator spaces Deeper aspects of the association between measurability poles and residues of spectral zeta functions and asymptotics of heat traces are studied Applications in Connes noncommutative geometry that are detailed include integration of quantum differentials measures on fractals and Connes character formula concerning the Hochschild class of the Chern character

A History of Physics: Phenomena, Ideas and Mechanisms Raffaele Pisano, 2024-09-19 The book gathers several contributions by historians of physics philosophers of science and scientists as new essays in the history of physics ranging across the entire field related in most instances to the works of Salvo D Agostino 1921 2020 one of the field s most prominent scholars since the second half of the past century A phenomenon is an observable measurable fact including data modelling assumptions laws A mechanical phenomenon is associated to equilibrium motion Are all mechanisms mechanisms of a phenomenon Scholars with different backgrounds discuss mechanism phenomena from an historical point of view The book is also devoted to understanding of causations of disequilibrium shock gravitational attraction repulsion inertia entropy etc including changes interaction in the framework of irregular cases of modern physics as well The book is an accessible avenue to understanding phenomena ideas and mechanisms by leading authorities who offer much needed historical insights into the field and on the relationship Physics Mathematics It provides an absorbing and revealing read for historians philosophers and scientists alike

Mathematical

Reviews ,2007 **The Dirac Spectrum** Nicolas Ginoux,2009-06-11 This volume surveys the spectral properties of the spin Dirac operator After a brief introduction to spin geometry we present the main known estimates for Dirac eigenvalues on compact manifolds with or without boundaries We give examples where the spectrum can be made explicit and present a chapter dealing with the non compact setting The methods mostly involve elementary analytical techniques and are therefore accessible for Master students entering the subject A complete and updated list of references is also included Advances in Automation II Andrey A. Radionov,Vadim R. Gasiyarov,2021-03-19 This book reports on innovative research and developments in automation Spanning a wide range of disciplines including communication engineering power engineering control engineering instrumentation signal processing and cybersecurity it focuses on methods and findings aimed at improving the control and monitoring of industrial and manufacturing processes as well as safety Based on the International Russian Automation Conference held on September 6 12 2020 in Sochi Russia the book provides academics and professionals with a timely overview of and extensive information on the state of the art in the field of automation and control systems and fosters new ideas and collaborations between groups in different countries

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