

Romeo Brunetti  
Claudio Dappiaggi  
Klaus Fredenhagen  
Jakob Yngvason *Editors*

# Advances in Algebraic Quantum Field Theory

# Advances In Algebraic Quantum Field Theory

## Mathematical Physics Studies

**Huzihiro Araki,Keiichi R. Ito,Akitaka  
Kishimoto,Izumi Ojima**

## **Advances In Algebraic Quantum Field Theory Mathematical Physics Studies:**

**Advances in Algebraic Quantum Field Theory** Romeo Brunetti, Claudio Dappiaggi, Klaus Fredenhagen, Jakob Yngvason, 2015-09-04 This text focuses on the algebraic formulation of quantum field theory from the introductory aspects to the applications to concrete problems of physical interest. The book is divided in thematic chapters covering both introductory and more advanced topics. These include the algebraic perturbative approach to interacting quantum field theories algebraic quantum field theory on curved spacetimes from its structural aspects to the applications in cosmology and to the role of quantum spacetimes algebraic conformal field theory the Kitaev's quantum double model from the point of view of local quantum physics and constructive aspects in relation to integrable models and deformation techniques. The book is addressed to master and graduate students both in mathematics and in physics who are interested in learning the structural aspects and the applications of algebraic quantum field theory *Advances in Algebraic Quantum Field Theory* Romeo Brunetti, Claudio Dappiaggi, Klaus Fredenhagen, Jakob Yngvason, 2015 This text focuses on the algebraic formulation of quantum field theory from the introductory aspects to the applications to concrete problems of physical interest. The book is divided in thematic chapters covering both introductory and more advanced topics. These include the algebraic perturbative approach to interacting quantum field theories algebraic quantum field theory on curved spacetimes from its structural aspects to the applications in cosmology and to the role of quantum spacetimes algebraic conformal field theory the Kitaev's quantum double model from the point of view of local quantum physics and constructive aspects in relation to integrable models and deformation techniques. The book is addressed to master and graduate students both in mathematics and in physics who are interested in learning the structural aspects and the applications of algebraic quantum field theory

**Perturbative Algebraic Quantum Field Theory** Kasia Rejzner, 2016-03-16 Perturbative Algebraic Quantum Field Theory pAQFT the subject of this book is a complete and mathematically rigorous treatment of perturbative quantum field theory pQFT that doesn't require the use of divergent quantities and works on a large class of Lorenzian manifolds. We discuss in detail the examples of scalar fields gauge theories and the effective quantum gravity pQFT models describe a wide range of physical phenomena and have remarkable agreement with experimental results. Despite this success the theory suffers from many conceptual problems pAQFT is a good candidate to solve many if not all of these conceptual problems. Chapters 1-3 provide some background in mathematics and physics Chapter 4 concerns classical theory of the scalar field which is subsequently quantized in chapters 5 and 6 Chapter 7 covers gauge theory and chapter 8 discusses effective quantum gravity. The book aims to be accessible to researchers and graduate students who are interested in the mathematical foundations of pQFT **Reality and Measurement in Algebraic Quantum Theory** Masanao Ozawa, Jeremy Butterfield, Hans Halvorson, Miklós Rédei, Yuichiro Kitajima, Francesco Buscemi, 2018-11-02 This volume contains papers based on presentations at the Nagoya Winter Workshop 2015 Reality and Measurement in Algebraic Quantum Theory NWW

2015 held in Nagoya Japan in March 2015 The foundations of quantum theory have been a source of mysteries puzzles and confusions and have encouraged innovations in mathematical languages to describe analyze and delineate this wonderland Both ontological and epistemological questions about quantum reality and measurement have been placed in the center of the mysteries explored originally by Bohr Heisenberg Einstein and Schrödinger This volume describes how those traditional problems are nowadays explored from the most advanced perspectives It includes new research results in quantum information theory quantum measurement theory information thermodynamics operator algebraic and category theoretical foundations of quantum theory and the interplay between experimental and theoretical investigations on the uncertainty principle This book is suitable for a broad audience of mathematicians theoretical and experimental physicists and philosophers of science

### **Mathematical Aspects of Quantum Field Theories** Damien Calaque, Thomas

Strobl, 2015-01-06 Despite its long history and stunning experimental successes the mathematical foundation of perturbative quantum field theory is still a subject of ongoing research This book aims at presenting some of the most recent advances in the field and at reflecting the diversity of approaches and tools invented and currently employed Both leading experts and comparative newcomers to the field present their latest findings helping readers to gain a better understanding of not only quantum but also classical field theories Though the book offers a valuable resource for mathematicians and physicists alike the focus is more on mathematical developments This volume consists of four parts The first Part covers local aspects of perturbative quantum field theory with an emphasis on the axiomatization of the algebra behind the operator product expansion The second Part highlights Chern Simons gauge theories while the third examines semi classical field theories In closing Part 4 addresses factorization homology and factorization algebras

### *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 Approach are discussed. Towards the end a panel discussion on Where Should Quantum Analysis Go was held **Quantum Field Theory and Gravity** Felix Finster, Olaf Müller, Marc Nardmann, Jürgen Tolksdorf, Eberhard Zeidler, 2012-02-08 One of the most challenging problems of contemporary theoretical physics is the mathematically rigorous construction of a theory which describes gravitation and the other fundamental physical interactions within a common framework. The physical ideas which grew from attempts to develop such a theory require highly advanced mathematical methods and radically new physical concepts. This book presents different approaches to a rigorous unified description of quantum fields and gravity. It contains a carefully selected cross section of lively discussions which took place in autumn 2010 at the fifth conference Quantum field theory and gravity: Conceptual and mathematical advances in the search for a unified framework in Regensburg, Germany. In the tradition of the other proceedings covering this series of conferences a special feature of this book is the exposition of a wide variety of approaches with the intention to facilitate a comparison. The book is mainly addressed to mathematicians and physicists who are interested in fundamental questions of mathematical physics. It allows the reader to obtain a broad and up to date overview of a fascinating active research area.

Progress and Visions in Quantum Theory in View of Gravity Felix Finster, Domenico Giulini, Johannes Kleiner, Jürgen Tolksdorf, 2020-04-09 This book focuses on a critical discussion of the status and prospects of current approaches in quantum mechanics and quantum field theory in particular concerning gravity. It contains a carefully selected cross section of lectures and discussions at the seventh conference Progress and Visions in Quantum Theory in View of Gravity which took place in fall 2018 at the Max Planck Institute for Mathematics in the Sciences in Leipzig. In contrast to usual proceeding volumes instead of reporting on the most recent technical results contributors were asked to discuss visions and new ideas in foundational physics in particular concerning foundations of quantum field theory. A special focus has been put on the question of which physical principles of quantum field theory can be considered fundamental in view of gravity. The book is mainly addressed to mathematicians and physicists who are interested in fundamental questions of mathematical physics. It allows the reader to obtain a broad and up to date overview of a fascinating active research area. Involutive Category Theory Donald Yau, 2020-11-30 This monograph introduces involutive categories and involutive operads featuring applications to the GNS construction and algebraic quantum field theory. The author adopts an accessible approach for readers seeking an overview of involutive category theory from the basics to cutting edge applications. Additionally the author's own recent advances in the area are featured never having appeared previously in the literature. The opening chapters offer an introduction to basic category theory ideal for readers new to the area. Chapters three through five feature previously unpublished results on coherence and strictification of involutive categories and involutive monoidal categories showcasing the author's state of the art research. Chapters on coherence of involutive symmetric monoidal categories and categorical GNS construction follow. The last chapter covers involutive operads and lays important coherence foundations for applications to algebraic quantum

field theory With detailed explanations and exercises throughout Involutive Category Theory is suitable for graduate seminars and independent study Mathematicians and mathematical physicists who use involutive objects will also find this a valuable reference **Analysis, PDEs, and Applications** Zhirayr Avetisyan, Michael Ruzhansky, Armen

Vagharshakyan, 2025-09-19 The present volume collects extended abstracts of lectures and talks presented at the Summer School and Conference Analysis PDEs and Applications held 24 June 6 July 2024 at Yerevan State University Armenia The thematic scope of contributions includes linear and non linear partial differential equations spectral theory and microlocal analysis harmonic and functional analysis theory of functions and approximation theory and applications in mathematical physics Each talk or lecture begins with a survey of a body of mathematical work either classic or modern leading up to recent advances This is followed by an exposition of either a specific research problem or a broader area of modern mathematical research presented by an expert in the field The volume will be of interest to not only students and young researchers but also experts looking for a crash course in the main concepts and ideas in one of the many advanced mathematical topics discussed

**Advances in Algebraic Quantum Field Theory** Romeo Brunetti, Claudio

Dappiaggi, Klaus Fredenhagen, Jakob Yngvason, 2015-09-15 This text focuses on the algebraic formulation of quantum field theory from the introductory aspects to the applications to concrete problems of physical interest The book is divided in thematic chapters covering both introductory and more advanced topics These include the algebraic perturbative approach to interacting quantum field theories algebraic quantum field theory on curved spacetimes from its structural aspects to the applications in cosmology and to the role of quantum spacetimes algebraic conformal field theory the Kitaev s quantum double model from the point of view of local quantum physics and constructive aspects in relation to integrable models and deformation techniques The book is addressed to master and graduate students both in mathematics and in physics who are interested in learning the structural aspects and the applications of algebraic quantum field theory

[Hawking Radiation: From Astrophysical Black Holes To Analogous Systems In Lab](#) Francesco D Belgiorno, Sergio L Cacciatori, Daniele

Faccio, 2018-07-09 The book can be a good introduction to research in the area of black hole physics Also it can serve as a source book for the established researcher in the field The book contains an extensive bibliography the contents of which are amply cited throughout the text The book well documents the historical development of the theory of Hawking radiation and related topics The book is a worthwhile addition to the physics literature on a topic of considerable interest zbMATHThe aim of this book is to provide the reader with a guide to Hawking radiation through a dual approach to the problem After an introductory chapter containing some basic knowledge about black holes and quantum field theory in curved spacetime the first part of the book consists in a survey of methods for deriving and studying Hawking radiation from astrophysical black holes from the original calculation by S W Hawking to the most recent contributions involving tunneling and gravitational anomalies In the second part we introduce analogue gravity and we focus our attention to dielectric black hole systems to

which the studies of the present authors are devoted The mutual interchange of knowledge between the aforementioned parts is addressed to render a more comprehensive picture of this very fascinating quantum phenomenon associated with black holes *Wormholes, Warp Drives and Energy Conditions* Francisco S. N. Lobo,2017-05-16 Top researchers in the field of gravitation present the state of the art topics outlined in this book ranging from the stability of rotating wormholes solutions supported by ghost scalar fields modified gravity applied to wormholes the study of novel semi classical and nonlinear energy conditions to the applications of quantum effects and the superluminal version of the warp drive in modified spacetime Based on Einstein's field equations this cutting edge research area explores the more far fetched theoretical outcomes of General Relativity and relates them to quantum field theory This includes quantum energy inequalities flux energy conditions and wormhole curvature and sheds light on not just the theoretical physics but also on the possible applications to warp drives and time travel This book extensively explores the physical properties and characteristics of these exotic spacetimes describing in detail the general relativistic geometries that generate closed timelike curves *Geometric Analysis and Applications to Quantum Field Theory* Peter Bouwknegt,Sye Wu,2002-02-08 In the last decade there has been an extraordinary confluence of ideas in mathematics and theoretical physics brought about by pioneering discoveries in geometry and analysis The various chapters in this volume treating the interface of geometric analysis and mathematical physics represent current research interests No suitable succinct account of the material is available elsewhere Key topics include A self contained derivation of the partition function of Chern Simons gauge theory in the semiclassical approximation D H Adams Algebraic and geometric aspects of the Knizhnik Zamolodchikov equations in conformal field theory P Bouwknegt Application of the representation theory of loop groups to simple models in quantum field theory and to certain integrable systems A L Carey and E Langmann A study of variational methods in Hermitian geometry from the viewpoint of the critical points of action functionals together with physical backgrounds A Harris A review of monopoles in nonabelian gauge theories M K Murray Exciting developments in quantum cohomology Y Ruan The physics origin of Seiberg Witten equations in 4 manifold theory S Wu Graduate students mathematicians and mathematical physicists in the above mentioned areas will benefit from the user friendly introductory style of each chapter as well as the comprehensive bibliographies provided for each topic Prerequisite knowledge is minimal since sufficient background material motivates each chapter *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

**Introduction to Algebraic Quantum Field Theory** S.S.

Horuzhy,1990-06-30 Et moi si j avait su comment en revenir One service mathematics has rendered the human race It has put common sense back je n y serais point aile Jules Verne where it belongs on the topmost shelf next to the dusty canister labelled discarded non The series is divergent therefore we may be sense Eric T Bell able to do something with it o Heaviside Mathematics is a tool for thought A highly necessary tool in a world where both feedback and non linearities abound Similarly all kinds of parts of mathematics serve as tools for other parts and for other sciences Applying a simple rewriting rule to the quote on the right above one finds such statements as One service topology has rendered mathematical physics One service logic has rendered computer science One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the raison d etre of this series

*Mathematical Physics in Mathematics and Physics* Roberto Longo,2001 The beauty and the mystery surrounding the interplay between mathematics and physics is captured by E Wigner s famous expression The unreasonable effectiveness of mathematics We don t know why but physical laws are described by mathematics and good mathematics sooner or later finds applications in physics often in a surprising way In this sense mathematical physics is a very old subject as Egyptian Phoenician or Greek history tells us But mathematical physics is a very modern subject as any working mathematician or physicist can witness It is a challenging discipline that has to provide results of interest for both mathematics and physics Ideas and motivations from both these sciences give it a vitality and freshness that is difficult to find anywhere else One of the big physical revolutions in the

twentieth century quantum physics opened a new magnificent era for this interplay. With the appearance of noncommutative analysis the role of classical calculus has been taken by commutation relations a subject still growing in an astonishing way. A good example where mathematical physics showed its power beauty and interdisciplinary character is the Doplicher Haag Roberts analysis of superselection sectors in the late 1960s. Not only did this theory explain the origin of statistics and classify it but year after year new connections have merged for example with Tomita Takesaki modular theory Jones theory of subfactors and Doplicher Roberts abstract duality for compact groups. This volume contains the proceedings of the conference Mathematical Physics in Mathematics and Physics dedicated to Sergio Doplicher and John E Roberts held in Siena Italy. The articles offer current research in various fields of mathematical physics primarily concerning quantum aspects of operator algebras.

### Periods in Quantum Field Theory and Arithmetic José Ignacio Burgos Gil, Kurusch Ebrahimi-Fard, Herbert Gangl, 2020-03-14

This book is the outcome of research initiatives formed during the special Research Trimester on Multiple Zeta Values Multiple Polylogarithms and Quantum Field Theory at the ICMAT Instituto de Ciencias Matemáticas Madrid in 2014. The activity was aimed at understanding and deepening recent developments where Feynman and string amplitudes on the one hand and periods and multiple zeta values on the other have been at the heart of lively and fruitful interactions between theoretical physics and number theory over the past few decades. In this book the reader will find research papers as well as survey articles including open problems on the interface between number theory quantum field theory and string theory written by leading experts in the respective fields. Topics include among others elliptic periods viewed from both a mathematical and a physical standpoint further relations between periods and high energy physics including cluster algebras and renormalisation theory multiple Eisenstein series and  $q$  analogues of multiple zeta values also in connection with renormalisation double shuffle and duality relations alternative presentations of multiple zeta values using Ecalle's theory of moulds and arborification a distribution formula for generalised complex and  $l$  adic polylogarithms Galois action on knots. Given its scope the book offers a valuable resource for researchers and graduate students interested in topics related to both quantum field theory in particular scattering amplitudes and number theory.

### **Mathematical Theory of Quantum Fields** Huzihiro Araki, 1999-10-22

This is an introduction to the mathematical foundations of quantum field theory using operator algebraic methods and emphasizing the link between the mathematical formulations and related physical concepts. It starts with a general probabilistic description of physics which encompasses both classical and quantum physics. The basic key physical notions are clarified at this point. It then introduces operator algebraic methods for quantum theory and goes on to discuss the theory of special relativity scattering theory and sector theory in this context.

### *Advances in String Theory* Eric R. Sharpe, Arthur Greenspoon, 2008

Over the past decade string theory has had an increasing impact on many areas of physics high energy and hadronic physics gravitation and cosmology mathematical physics and even condensed matter physics. The impact has been through many major conceptual and methodological developments in

quantum field theory in the past fifteen years In addition string theory has exerted a dramatic influence on developments in contemporary mathematics including Gromov Witten theory mirror symmetry in complex and symplectic geometry and important ramifications in enumerative geometry This volume is derived from a conference of younger leading practitioners around the common theme What is string theory The talks covered major current topics both mathematical and physical related to string theory Graduate students and research mathematicians interested in string theory in mathematics and physics will be interested in this workshop BOOK JACKET

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