

## Algebraic geometry informs perturbative quantum field theory

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Single-scale Feynman diagrams yield integrals that are periods, namely projective integrals of rational functions of Schwinger parameters. Algebraic geometry may therefore inform us of the types of number to which these integrals evaluate. We give examples at 3, 4 and 6 loops of massive Feynman diagrams that evaluate to Dirichlet  $L$ -series of modular forms and examples at 6, 7 and 8 loops of counterterms that evaluate to multiple zeta values or polylogarithms of the sixth root of unity. At 8 loops and beyond, algebraic geometry informs us that polylogs are insufficient for the evaluation of terms in the beta-function of  $\phi^4$  theory. Here, modular forms appear as obstructions to polylogarithmic evaluation.

*In memoriam Jochen Fleischer (1937-2013)*

*Loops and Legs in Quantum Field Theory*  
27 April 2014 - 02 May 2014  
Würzburg, Germany

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<sup>a</sup>Speaker

# Pdf Perturbative Algebraic Quantum Field Theory

**Eberhard Zeidler**

## Pdf Perturbative 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

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

*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

*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 Ecalles theory of moulds and arborification a distribution formula for generalised complex and 1adic 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

**Perturbative Algebraic Quantum Field Theory at Finite Temperature** Falk Lindner,2013 **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

**Quantum Field Theory II: Quantum Electrodynamics** Eberhard Zeidler,2008-09-03 And God said Let there be light and there was light Genesis 1 3 Light is not only the basis of our biological existence but also an essential source of our knowledge about the physical laws of nature ranging from the seventeenth century geometrical optics up to the twentieth century theory of general relativity and quantum electrodynamics Folklore Don t give us numbers give us insight A contemporary natural scientist to a mathematician The present book is the second volume of a comprehensive introduction to the mathematical and physical aspects of modern quantum field theory which comprehends the following six volumes Volume I Basics in Mathematics and Physics Volume II Quantum Electrodynamics Volume III Gauge Theory Volume IV Quantum Mathematics Volume V The Physics of the Standard Model Volume VI Quantum

Gravitation and String Theory It is our goal to build a bridge between mathematicians and physicists based on the challenging question about the fundamental forces in macrocosmos the universe and microcosmos the world of elementary particles The six volumes address a broad audience of readers including both und graduate and graduate students as well as experienced scientists who want to become familiar with quantum eld theory which is a fascinating topic in modern mathematics and physics *Scientific Realism and the Quantum* Steven French,Juha Saatsi,2020 Quantum theory explains a hugely diverse array of phenomena in the history of science But how can the world be the way quantum theory says it is Fifteen expert scholars consider what the world is like according to quantum physics in this volume and offer illuminating new perspectives on fundamental debates that span physics and philosophy *The Philosophy and Physics of Noether's Theorems* James Read,Nicholas J. Teh,2022-09-29 In 1918 Emmy Noether in her paper Invariante Variationsprobleme proved two theorems and their converses on variational problems that went on to revolutionise theoretical physics 100 years later the mathematics of Noether s theorems continues to be generalised and the physical applications of her results continue to diversify This centenary volume brings together world leading historians philosophers physicists and mathematicians in order to clarify the historical context of this work its foundational and philosophical consequences and its myriad physical applications Suitable for advanced undergraduate and graduate students and professional researchers this is a go to resource for those wishing to understand Noether s work on variational problems and the profound applications which it finds in contemporary physics *The Message of Quantum Science* Philippe Blanchard,Jürg Fröhlich,2015-04-07 This collection of essays is above all intended to pay tribute to the fact that while QM today is a refined and incredibly successful instrument many issues concerning the internal consistency and the interpretation of this theory are still not nearly as well understood as they ought to be In addition whenever possible these essays take the opportunity to link foundational issues to the many exciting developments that are often linked to major experimental and technological breakthroughs in exploiting the electromagnetic field and in particular its quantum properties and its interactions with matter as well as to advances in solid state physics such as new quantum Hall liquids topological insulators and graphene The present volume also focuses on various areas including new interference experiments with very large molecules passing through double slits which test the validity of the Kochen Specker theorem new tests of the violation of Bell s inequalities and the consequences of entanglement new non demolition measurements and tests of wave function collapse to name but a few These experimental developments have raised many challenging questions for theorists leading to a new surge of interest in the foundations of QM which have puzzled physicists ever since this theory was pioneered almost ninety years ago The outcome of a seminar program of the same name on foundational issues in quantum physics QM organized by the editors of this book and addressing newcomers to the field and more seasoned specialists alike this volume provides a pedagogically inspired snapshot view of many of the unresolved issues in the field of foundational QM *Conformal Symmetry and Chirality in Perturbative Algebraic Quantum*

Field Theory Samuel James Crawford,2021    **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.    *Algebraic Quantum Field Theory, Perturbation Theory, and the Loop Expansion* Michael Dütsch, Klaus Fredenhagen, 2000    **From Classical Field Theory to Perturbative Quantum Field Theory** Michael Dütsch, 2019-03-18 This book develops a novel approach to perturbative quantum field theory starting with a perturbative formulation of classical field theory. Quantization is achieved by means of deformation quantization of the underlying free theory and by applying the principle that as much of the classical structure as possible should be maintained. The resulting formulation of perturbative quantum field theory is a version of the Epstein-Glaser renormalization that is conceptually clear, mathematically rigorous and pragmatically useful for physicists. The connection to traditional formulations of perturbative quantum field theory is also elaborated on and the formalism is illustrated in a wealth of examples and exercises.    *Introduction to Algebraic Quantum Field Theory* S.S. Horuzhy, 2012-12-06 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 aille 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'être of this series.    **Energy Research Abstracts**, 1982

**Mathematical Reviews**, 2005    Algebraic Renormalization Olivier Piguet, Silvio P. Sorella, 2008-09-11 The idea of this book originated from two series of lectures given by us at the Physics Department of the Catholic University of Petrópolis in Brazil. Its aim is to present an introduction to the algebraic method in the perturbative renormalization of relativistic quantum field theory. Although this approach goes back to the pioneering works of Symanzik in the early 1970s and was systematized by Becchi, Rouet and Stora as early as 1972-1974 its full value has not yet been widely appreciated by the

practitioners of quantum field theory Becchi Rouet and Stora have however shown it to be a powerful tool for proving the renormalizability of theories with broken symmetries and of gauge theories We have thus found it pertinent to collect in a self contained manner the available information on algebraic renormalization which was previously scattered in many original papers and in a few older review articles Although we have taken care to adapt the level of this book to that of a post graduate Ph D course more advanced researchers will also certainly find it useful The deeper knowledge of renormalization theory we hope readers will acquire should help them to face the difficult problems of quantum field theory It should also be very helpful to the more phenomenology oriented readers who want to familiarize themselves with the formalism of renormalization theory a necessity in view of the sophisticated perturbative calculations currently being done in particular in the standard model of particle interactions     *High Energy Physics Index* ,1985     **Physics Briefs** ,1994

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