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Monographs  
in Physics

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**Random Walks,  
Critical Phenomena,  
and Triviality  
in Quantum Field Theory**



Springer-Verlag Berlin Heidelberg GmbH

# Random Walks Critical Phenomena And Triviality In Quantum Field Theory

**Jan Dereziński, Christian Gerard**



## **Random Walks Critical Phenomena And Triviality In Quantum Field Theory:**

**Random Walks, Critical Phenomena, and Triviality in Quantum Field Theory** Roberto Fernandez, Jürg Fröhlich, Alan D. Sokal, 2013-03-14 Simple random walks or equivalently sums of independent random variables have long been a standard topic of probability theory and mathematical physics In the 1950s non Markovian random walk models such as the self avoiding walk were introduced into theoretical polymer physics and gradually came to serve as a paradigm for the general theory of critical phenomena In the past decade random walk expansions have evolved into an important tool for the rigorous analysis of critical phenomena in classical spin systems and of the continuum limit in quantum field theory Among the results obtained by random walk methods are the proof of triviality of the  $\phi^4$  quantum field theory in space time dimension  $d = 4$  and the proof of mean field critical behavior for  $\phi^4$  and Ising models in space dimension  $d = 4$  The principal goal of the present monograph is to present a detailed review of these developments It is supplemented by a brief excursion to the theory of random surfaces and various applications thereof This book has grown out of research carried out by the authors mainly from 1982 until the middle of 1985 Our original intention was to write a research paper However the writing of such a paper turned out to be a very slow process partly because of our geographical separation partly because each of us was involved in other projects that may have appeared more urgent Elements of the Random Walk Joseph

Rudnick, George Gaspari, 2004-03-04 Random walks have proven to be a useful model in understanding processes across a wide spectrum of scientific disciplines Elements of the Random Walk is an introduction to some of the most powerful and general techniques used in the application of these ideas The mathematical construct that runs through the analysis of the topics covered in this book unifying the mathematical treatment is the generating function Although the reader is introduced to analytical tools such as path integrals and field theoretical formalism the book is self contained in that basic concepts are developed and relevant fundamental findings fully discussed Mathematical background is provided in supplements at the end of each chapter when appropriate This text will appeal to graduate students across science engineering and mathematics who need to understand the applications of random walk techniques as well as to established researchers

Non-perturbative Quantum Field Theory: Mathematical Aspects And Applications Jurg Fröhlich, 1992-04-29 Compiled to illustrate the recent history of Quantum Field Theory and its trends this collection of selected reprints by Jürg Fröhlich a leading theoretician in the field is a comprehensive guide of the more mathematical aspects of the subject Results and methods of the past fifteen years are reviewed The analytical methods employed are non perturbative and for the larger part mathematically rigorous Most articles are review articles surveying certain important developments in quantum field theory and guiding the reader towards the original literature The volume begins with a comprehensive introduction by Jürg Fröhlich The theory of phase transitions and continuous symmetry breaking is reviewed in the first section The second section discusses the non perturbative quantization of topological solitons The third section is devoted to the study of gauge fields A

paper on the triviality of  $\phi^4$  theory in four and more dimensions is found in the fourth section while the fifth contains two articles on random geometry The sixth and final part addresses topics in low dimensional quantum field theory including braid statistics two dimensional conformal field theory and an application to condensed matter theory

**Progress in High-Dimensional Percolation and Random Graphs** Markus Heydenreich, Remco van der Hofstad, 2017-11-22 This text presents an engaging exposition of the active field of high dimensional percolation that will likely provide an impetus for future work With over 90 exercises designed to enhance the reader's understanding of the material as well as many open problems the book is aimed at graduate students and researchers who wish to enter the world of this rich topic The text may also be useful in advanced courses and seminars as well as for reference and individual study Part I consisting of 3 chapters presents a general introduction to percolation stating the main results defining the central objects and proving its main properties No prior knowledge of percolation is assumed Part II consisting of Chapters 4-9 discusses mean field critical behavior by describing the two main techniques used namely differential inequalities and the lace expansion In Parts I and II all results are proved making this the first self contained text discussing high dimensional percolation Part III consisting of Chapters 10-13 describes recent progress in high dimensional percolation Partial proofs and substantial overviews of how the proofs are obtained are given In many of these results the lace expansion and differential inequalities or their discrete analogues are central Part IV consisting of Chapters 14-16 features related models and further open problems with a focus on the big picture

Statistical Mechanics of Lattice Systems Sacha Friedli, Yvan Velenik, 2017-11-23 A self contained mathematical introduction to the driving ideas in equilibrium statistical mechanics studying important models in detail

**Introduction to a Renormalisation Group Method** Roland Bauerschmidt, David C. Brydges, Gordon Slade, 2019-10-16 This is a primer on a mathematically rigorous renormalisation group theory presenting mathematical techniques fundamental to renormalisation group analysis such as Gaussian integration perturbative renormalisation and the stable manifold theorem It also provides an overview of fundamental models in statistical mechanics with critical behaviour including the Ising and  $\phi^4$  models and the self avoiding walk The book begins with critical behaviour and its basic discussion in statistical mechanics models and subsequently explores perturbative and non perturbative analysis in the renormalisation group Lastly it discusses the relation of these topics to the self avoiding walk and supersymmetry Including exercises in each chapter to help readers deepen their understanding it is a valuable resource for mathematicians and mathematical physicists wanting to learn renormalisation group theory

*Spectral Theory and Mathematical Physics: A Festschrift in Honor of Barry Simon's 60th Birthday* Fritz Gesztesy, 2007 This Festschrift had its origins in a conference called SimonFest held at Caltech March 27-31 2006 to honor Barry Simon's 60th birthday It is not a proceedings volume in the usual sense since the emphasis of the majority of the contributions is on reviews of the state of the art of certain fields with particular focus on recent developments and open problems The bulk of the articles in this Festschrift are of this survey form and a few review Simon's

contributions to a particular area Part 1 contains surveys in the areas of Quantum Field Theory Statistical Mechanics Nonrelativistic Two Body and N Body Quantum Systems Resonances Quantum Mechanics with Electric and Magnetic Fields and the Semiclassical Limit Part 2 contains surveys in the areas of Random and Ergodic Schrodinger Operators Singular Continuous Spectrum Orthogonal Polynomials and Inverse Spectral Theory In several cases this collection of surveys portrays both the history of a subject and its current state of the art A substantial part of the contributions to this Festschrift are survey articles on the state of the art of certain areas with special emphasis on open problems This will benefit graduate students as well as researchers who want to get a quick yet comprehensive introduction into an area covered in this volume

**Random Magnetism, High Temperature Superconductivity: Proceedings Of T Raymond L Orbach Inauguration Symposium** Nai-li Haung Liu, Ward P Beyermann, Douglas E Maclaughlin, 1994-10-25 On 19 March 1993 Raymond L Orbach was inaugurated as the eighth Chancellor of the University of California Riverside In connection with this occasion a two day scientific symposium was held Invited and contributed papers were presented on subjects related to 2 vital areas of condensed matter physics in which Chancellor Orbach has made seminal contributions the effects of disorder on magnetic behavior and the theory of high temperature superconductivity The papers in this book many of which are by outstanding contributors to these important fields give an up to date overview of recent progress *Poincaré Seminar 2002* Vincent Rivasseau, 2003-04-24 The Poincar Seminar is held twice a year at the Institut Henri Poincar in Paris This volume contains the lectures of the 2002 seminars The main topic of the first one was the vacuum energy in particular the Casimir effect and the nature of the cosmological constant The second one concentrated on renormalization giving a comprehensive account of its mathematical structure and applications to high energy physics statistical mechanics and classical mechanics Students will find excellent introductions to the subjects with further lectures leading to the frontiers of experimental and theoretical research scientists will profit from contributions by outstanding experts **Analysis On Fock Spaces And Mathematical Theory Of Quantum Fields: An Introduction To Mathematical Analysis Of Quantum Fields** Asao Arai, 2017-12-20 This book provides a comprehensive introduction to Fock space theory and its applications to mathematical quantum field theory The first half of the book Part I is devoted to detailed descriptions of analysis on abstract Fock spaces full Fock space boson Fock space fermion Fock space and boson fermion Fock space It includes the mathematics of second quantization representation theory of canonical commutation relations and canonical anti commutation relations Bogoliubov transformations infinite dimensional Dirac operators and supersymmetric quantum field in an abstract form The second half of the book Part II covers applications of the mathematical theories in Part I to quantum field theory Four kinds of free quantum fields are constructed and detailed analyses are made A simple interacting quantum field model called the van Hove model is fully analyzed in an abstract form Moreover a list of interacting quantum field models is presented and a short description to each model is given To graduate students in mathematics or physics who are interested in the mathematical

aspects of quantum field theory this book is a good introductory text It is also well suited for self study and will provide readers a firm foundation of knowledge and mathematical techniques for reading more advanced books and current research articles in the field of mathematical analysis on quantum fields Also numerous problems are added to aid readers to develop a deeper understanding of the field

**Mathematical Concepts of Quantum Mechanics** Stephen J. Gustafson, Israel Michael Sigal, 2011-09-24 The book gives a streamlined introduction to quantum mechanics while describing the basic mathematical structures underpinning this discipline Starting with an overview of key physical experiments illustrating the origin of the physical foundations the book proceeds with a description of the basic notions of quantum mechanics and their mathematical content It then makes its way to topics of current interest specifically those in which mathematics plays an important role The more advanced topics presented include many body systems modern perturbation theory path integrals the theory of resonances quantum statistics mean field theory second quantization the theory of radiation non relativistic quantum electrodynamics and the renormalization group With different selections of chapters the book can serve as a text for an introductory intermediate or advanced course in quantum mechanics The last four chapters could also serve as an introductory course in quantum field theory

*The Quantum Theory of Fields* Steven Weinberg, 1995 A comprehensive introduction to quantum field theory by Nobel Laureate Steven Weinberg first published in 1996

Renormalization Manfred Salmhofer, 2013-03-14 Why another book on the renormalization of field theory This book aims to contribute to the bridging of the gap between the treatments of renormalization in physics courses and the mathematically rigorous approach It provides a simple but rigorous introduction to perturbative renormalization and in doing so also equips the reader with some basic techniques which are a prerequisite for studying renormalization nonperturbatively Beside these technical issues it also contains a proof of renormalizability of 4 theory in  $d = 5 - 4$  dimensions and a discussion of renormalization for systems with a Fermi surface which are realistic models for electrons in metals Like the two courses on which it is based the book is intended to be easily accessible to mathematics and physics students from the third year on and after going through it one should be able to start reading the current literature on the subject in particular on nonperturbative renormalization Chapter 1 provides a brief motivation for studying quantum theory by functional integrals as well as the setup In Chap 2 the techniques of Gaussian integration and Feynman graph expansions are introduced I then give simple proofs of basic results such as the theorem that the logarithm of the generating functional is a sum of values of connected Feynman graphs In Chap 3 the Wilson renormalization flow is defined and perturbative renormalizability of 4 theory in  $d = 5 - 4$  dimensions is proven using a renormalization group differential equation The Feynman graph expansion of Chap

Quantum Theory and Symmetries Heinz Dietrich Doebner, 2000 This volume gives an overview of the recent representative developments in relativistic and non relativistic quantum theory which are related to the application of various mathematical notions of various symmetries These notions are centered upon groups algebras and their generalizations and are applied in interaction

with topology differential geometry functional analysis and related fields The emphasis is on results in the following areas foundation of quantum physics quantization methods nonlinear quantum mechanics algebraic quantum field theory gauge and string theories discrete spaces quantum groups and generalized symmetries *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

*The Quantum Theory of Fields: Volume 2, Modern Applications* Steven Weinberg, 1996-08-13 The Quantum Theory of Fields first published in 1996 is a self contained comprehensive introduction to quantum field theory from Nobel Laureate Steven Weinberg Volume II gives an account of the methods of quantum field theory and how they have led to an understanding of the weak strong and electromagnetic interactions of the elementary particles The presentation of modern mathematical methods is throughout interwoven with accounts of the problems of elementary particle physics and condensed matter physics to which they have been applied Many topics are included that are not usually found in books on quantum field theory The book is peppered with examples and insights from the author's experience as a leader of elementary particle physics Exercises are included at the end of each chapter **Sojourns in Probability Theory and Statistical Physics - I**

Vladas Sidoravicius, 2019-10-17 Charles M Chuck Newman has been a leader in Probability Theory and Statistical Physics for nearly half a century This three volume set is a celebration of the far reaching scientific impact of his work It consists of articles by Chuck's collaborators and colleagues across a number of the fields to which he has made contributions of fundamental significance This publication was conceived during a conference in 2016 at NYU Shanghai that coincided with Chuck's 70th birthday The sub titles of the three volumes are I Spin Glasses and Statistical Mechanics II Brownian Web and Percolation III Interacting Particle Systems and Random Walks The articles in these volumes which cover a wide spectrum of topics will be especially useful for graduate students and researchers who seek initiation and inspiration in Probability Theory and Statistical Physics *Scattering Theory of Classical and Quantum N-Particle Systems* Jan Dereziński, Christian Gerard, 2013-03-09 This monograph addresses researchers and students It is a modern presentation of time dependent methods for studying problems of scattering theory in the classical and quantum mechanics of N particle systems Particular attention is paid to long range potentials For a large class of interactions the existence of the asymptotic velocity and the asymptotic completeness of the wave operators is shown The book is self contained and explains in detail concepts that deepen the understanding As a special feature of the book the beautiful analogy between classical and quantum scattering

theory e g for N body Hamiltonians is presented with deep insight into the physical and mathematical problems *Advances in Disordered Systems, Random Processes and Some Applications* Pierluigi Contucci, Cristian Giardinà, 2017 This book offers a unified perspective on the study of complex systems with contributions written by leading scientists from various disciplines including mathematics physics computer science biology economics and social science It is written for researchers from a broad range of scientific fields with an interest in recent developments in complex systems **Colloidal Particles in Critical Fluids** Frank Schlesener, 2004



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