Statistical Field Theory Volume 1 From Brownian Motion To Renormalization And Lattice Gauge Theory Cambridge Monographs On Mathematical Physics

Knowledge of the renormalization group and field theory is a key part of physics, and is essential in condensed matter and particle physics. Written for advanced undergraduate and beginning graduate students, this textbook provides a concise introduction to this su textbook deals directly with the loop expansion of the free energy, also known as the background field method. This is a powerful method, especially when dealing with symmetries, and statistical mechanics. In focussing on free energy, the author avoids long develo field theory techniques. The necessity of renormalization then follows.

This textbook presents a concise yet detailed introduction to quantum physics. Concise, because it condenses the essentials to a few principles. Detailed, because these few principles – necessarily rather abstract – are illustrated by several telling examples. A fairly overview of the conventional quantum mechanics curriculum is the primary focus, but the huge field of statistical thermodynamics is covered as well. The text explains why a few key discoveries shattered the prevailing broadly accepted classical view of physics. Firs appears to consist of particles which, when propagating, resemble waves. Consequently, some observable properties cannot be measured simultaneously with arbitrary precision. Second, events with single particles are not determined, but are more or less probable of this is that the observable properties of a physical system are to be represented by non-commuting mathematical objects instead of real numbers. Chapters on exceptionally simple, but highly instructive examples illustrate this abstract formulation of quantum phys simplest atoms, ions, and molecules are explained, describing their interaction with electromagnetic radiation as well as the scattering of particles. A short introduction to many particle physics with an outlook on quantum fields follows. There is a chapter on maximall states of very large systems, that is statistical thermodynamics. The following chapter on the linear response to perturbations provides a link to the material equations of continuum physics. Mathematical details which would hinder the flow of the main text have been to an appendix. The book addresses university students of physics and related fields. It will attract graduate students and professionals in particular who wish to systematize or refresh their knowledge of quantum physics when studying specialized texts on solid state materials physics, advanced optics, and other modern fields.

An Introduction to Quantum Field Theory is a textbook intended for the graduate physics course covering relativistic quantum mechanics, quantum electrodynamics, and Feynman diagrams. The authors make these subjects accessible through carefully worked exan illustrating the technical aspects of the subject, and intuitive explanations of what is going on behind the mathematics. After presenting the basics of quantum electrodynamics, the authors discuss the theory of renormalization and its relation to statistical mechanics, a introduce the renormalization group. This discussion sets the stage for a discussion of the physical principles that underlie the fundamental interactions of elementary particle physics and their description by gauge field theories.

This systematic algebraic approach offers a careful formulation of the problems' physical motivations as well as self-contained descriptions of the mathematical methods for arriving at solutions. 1972 edition.

The Theoretical Minimum

Probabilistic and Statistical Aspects of Quantum Theory

Statistical Field Theory

Path Integrals in Physics

Statistical Mechanics of Lattice Systems

A Modern Introduction to Quantum Field Theory

Providing a new perspective on quantum field theory, this book gives a pedagogical and up-to-date exposition of non-perturbative methods in relativistic quantum field theory and introduces the reader to modern research work in theoretical physics. It describes in detail non-perturbative methods in quantum field theory, and explores two- dimensional and four- dimensional gauge dynamics using those methods. The book concludes with a summary emphasizing the interplay between two- and four- dimensional gauge theories. Aimed at graduate students and researchers, this book covers topics from two-dimensional conformal symmetry, affine Lie algebras, solitons, integrable models, bosonization, and 't Hooft model, to four-dimensional conformal invariance, integrability, large N expansion, Skyrme model, monopoles and instantons. Applications, first to simple field theories and gauge dynamics in two dimensions, and then to gauge theories in four dimensions and quantum chromodynamics (QCD) in particular, are thoroughly described.

Describes random geometry and applications to strings, quantum gravity, topological field theory and membrane physics.

This book provides an introduction to the methods of coupled quantum statistical field theory and Green's functions. The methods of coupled quantum field theory have played a major role in the extensive development of nonrelativistic quantum many-particle theory and condensed matter physics. This introduction to the subject is intended to facilitate delivery of the material in an easily digestible form to advanced undergraduate physics majors at a relatively early stage of their scientific development. The main mechanism to accomplish this is the early introduction of variational calculus and the Schwinger Action Principle, accompanied by Green's functions. Important achievements of the theory in condensed matter and quantum statistical physics are reviewed in detail to help develop research capability. These include the derivation of coupled field Green's function equations-of-motion for a model electron-hole-phonon system, extensive discussions of retarded, thermodynamic and nonequilibrium Green's functions and their associated spectral representations and approximation procedures. Phenomenology emerging in these discussions include quantum plasma dynamic-nonlocal-screening, plasmons, polaritons, linear electromagnetic response, excitons, polarons, phonons, magnetic Landau quantization, van der Waals interactions, chemisorption, etc. Considerable attention is also given to low dimensional and nanostructured systems, including quantum wells, wires, dots and superlattices, as well as materials having exceptional conduction properties such as Superconductors, Superfluids and Graphene.

Quantum field theory has undergone extraordinary developments in the last few decades and permeates many branches of modern research such as particle physics, cosmology, condensed matter, statistical mechanics and critical phenomena. This book introduces the reader to the modern developments in a manner which assumes no previous knowledge of quantum field theory, and makes it readily accessible from the advanced undergraduate level upwards. - ;The importance and the beauty of modern quantum field theory resides in the power and variety of its methods and ideas, which find application in domain.

Lectures On Phase Transitions And The Renormalization Group

Elements of Statistical Mechanics

Sojourns in Probability Theory and Statistical Physics - I

Gauge Fields and Strings

Quantum Statistical Field Theory

Functional Methods in Quantum Field Theory and Statistical Physics

This 2006 textbook provides a concise introduction to the key concepts and tools of statistical mechanics. It also covers advanced topics such as non-relativistic quantum field theory and numerical methods. After introducing classical analytical techniques, such as cluster expansion and Landau theory, the authors present important numerical methods with applications to magnetic systems, Lennard-Jones fluids and biophysics. Quantum statistical mechanics is discussed in detail and applied to Bose-Einstein condensation and topics in astrophysics and cosmology. In order to describe emergent phenomena in interacting quantum systems, canonical non-relativistic quantum field theory is introduced and then reformulated in terms of Feynman integrals. Combining the authors' many years' experience of teaching courses in this area, this textbook is ideal for advanced undergraduate and graduate students in physics, chemistry and mathematics.

A master teacher presents the ultimate introduction to classical mechanics for people who are serious about learning physics "Beautifully clear explanations of famously 'difficult' things," -- Wall Street Journal If you ever regretted not taking physics in college -- or simply want to know how to think like a physicist -- this is the book for you. In this bestselling introduction to classical mechanics, physicist Leonard Susskind and hacker-scientist George Hrabovsky offer a first course in physics and associated math for the ardent amateur. Challenging, lucid, and concise, The Theoretical Minimum provides a tool kit for amateur scientists to learn physics at their own pace.

Exactly Solved Models in Statistical Mechanics

Statistical Field Theory: Volume 1, From Brownian Motion to Renormalization and Lattice Gauge TheoryCambridge University Press

Gauge Theories as a Problem of Constructive Quantum Field Theory and Statistical Mechanics

Quantum and Statistical Field Theory

Algebraic Methods in Statistical Mechanics and Quantum Field Theory

Statistical Approach to Quantum Field Theory

Exactly Solved Models in Statistical Mechanics

Statistical Methods in Quantum Optics 1

This volume contains a selection of expository articles on quantum field theory and statistical mechanics by James Glimm and Arthur Jaffe. They include a solution of the original interacting quantum field equations and a description of the physics which these equations contain. Quantum fields were proposed in the late 1920s as the natural framework which combines quantum theory with relativ ity. They have survived ever since. The mathematical description for quantum theory starts with a Hilbert space H of state vectors. Quantum fields are linear operators on this space, which satisfy nonlinear wave equations of fundamental physics, including coupled Dirac, Max well and Yang-Mills equations. The field operators are restricted to satisfy a "locality" requirement that they commute (or anti-commute in the case of fer mions) at space-like separated points. This condition is compatible with finite propagation speed, and hence with special relativity. Asymptotically, these fields converge for large time to linear fields describing free particles. Using these ideas a scattering theory had been developed, based on the existence of local quantum fields.

Covering the elementary aspects of the physics of phases transitions and the renormalization group, this popular book is widely used both for core graduate statistical mechanics courses as well as for more specialized courses. Emphasizing understanding and clarity rather than technical manipulation, these lectures de-mystify the subject and show precisely "how things work." Goldenfeld keeps in mind a reader who wants to understand why things are done, what the results are, and what in principle can go wrong. The book reaches both experimentalists and theorists, students and even active researchers, and assumes only a prior knowledge of statistical mechanics at the introductory graduate level.Advanced, never-before-printed topics on the applications of renormalization group far from equilibrium to partial differential equations add to the uniqueness of this book.

While many scientists are familiar with fractals, fewer are familiar with scale-invariance and universality which underlie the ubiquity of their shapes. These properties may emerge from the collective behaviour of simple fundamental constituents, and are studied using statistical field theories. Initial chapters connect the particulate perspective developed in the companion volume, to the coarse grained statistical fields studied here. Based on lectures taught by Professor Kardar at MIT, this textbook demonstrates how such theories are formulated and studied. Perturbation theory, exact solutions, renormalization groups, and other tools are employed to demonstrate the emergence of scale invariance and universality, and the non-equilibrium dynamics of interfaces and directed paths in random media are discussed. Ideal for advanced graduate courses in statistical physics, it contains an integrated set of problems, with solutions to selected problems at the end of the book and a complete set available to lecturers at www.cambridge.org/9780521873413.

In 1941, E.C.G. Stueckelberg wrote a paper, based on ideas of V. Fock, that established the foundations of a theory that could covariantly describe the classical and quantum relativistic mechanics of a single particle. Horwitz and Piron extended the applicability of this theory in 1973 (to be called the SHP theory) to the many-body problem. It is the purpose of this book to explain this development and provide examples of its applications. We first review the basic ideas of the SHP theory, both classical and quantum, and develop the appropriate form of electromagnetism on this dynamics. After studying the two body problem classically and quantum mechanically, we formulate the N-body problem. We then develop the general quantum scattering theory for the N-body problem and prove a quantum mechanical relativistically covariant form of the Gell-Mann-Low theorem. The quantum theory of relativistic spin is then developed, including spin-statistics, providing the necessary apparatus for Clebsch-Gordan additivity, and we then discuss the phenomenon of entanglement at unequal times. In the second part, we develop relativistic statistical mechanics, including a mechanism for stability of the off-shell mass, and a high temperature phase transition to the mass shell. Finally, some applications are given, such as the explanation of the Lindneret alexperiment, the proposed experiment of Palacios et al which should demonstrate relativistic entanglement (at unequal times), the space-time lattice, low energy nuclear reactions and applications to black hole physics.

Principles and Worked Examples

Collected Papers Vol.1: Quantum Field Theory and Statistical Mechanics

Statistical Physics of Fields

What You Need to Know to Start Doing Physics

Statistical Field Theory for Neural Networks

A Statistical Field Theory Approach

A self-contained, mathematical introduction to the driving ideas in equilibrium statistical mechanics, studying important models in detail.

This new expanded second edition has been totally revised and corrected. The reader finds two complete new chapters. One covers the exact solution of the finite temperature Schwinger model with periodic boundary conditions. This simple model supports instanton solutions - similarly as QCD - and allows for a detailed discussion of topological sectors in gauge theories, the anomaly-induced breaking of chiral symmetry and the intriguing role of fermionic zero modes. The other new chapter is devoted to interacting fermions at finite fermion density and finite temperature. Such low-dimensional models are used to describe long-energy properties of Dirac-type materials in condensed matter physics. The large-N solutions of the Gross-Neveu, Nambu-Jona-Lasinio and Thirring models are presented in great detail, where N denotes the number of fermion flavors. Towards the end of the book corrections to the large-N solution and simulation results of a finite number of fermion flavors are presented. Further problems are added at the end of each chapter in order to guide the reader to a deeper understanding of the presented topics. This book is meant for advanced students and young researchers who want to acquire the necessary tools and experience to produce research results in the statistical approach to Quantum Field Theory.

Most of the interesting and difficult problems in statistical mechanics arise when the constituent particles of the system interact with each other with pair or multipartiele energies. The types of behaviour which occur in systems because of these interactions are referred to as cooperative phenomena giving rise in many cases to phase transitions. This book and its companion volume (Lavis and Bell 1999, referred to in the text simply as Volume 1) are princi pally concerned with phase transitions in lattice systems. Due mainly to the insights gained from scaling theory and renormalization group methods, this subject has developed very rapidly over the last thirty years. ' In our choice of topics we have tried to present a good range of fundamental theory and of applications, some of which reflect our own interests. A broad division of material can be made between exact results and ap proximation methods. We have found it appropriate to inelude some of our discussion of exact results in this volume and some in Volume 1. Apart from this much of the discussion in Volume 1 is concerned with mean-field theory. Although this is known not to give reliable results elose to a critical region, it often provides a good qualitative picture for phase diagrams as a whole. For complicated systems some kind of mean-field method is often the only tractable method available. In this volume our main concern is with scaling theory, algebraic methods and the renormalization group.

This book presents a self-contained introduction to techniques from field theory applied to stochastic and collective dynamics in neuronal networks. These powerful analytical techniques, which are well established in other fields of physics, are the basis of current developments and offer solutions to pressing open problems in theoretical neuroscience and also machine learning. They enable a systematic and quantitative understanding of the dynamics in recurrent and stochastic neuronal networks. This book is intended for physicists, mathematicians, and computer scientists and it is designed for self-study by researchers who want to enter the field or as the main text for a one semester course at advanced undergraduate or graduate level. The theoretical concepts presented in this book are systematically developed from the very beginning, which only requires basic knowledge of analysis and linear algebra.

An Introduction

Introduction to Statistical Field Theory

Statistical Field Theory: Volume 1, From Brownian Motion to Renormalization and Lattice Gauge Theory

Scaling and Renormalization in Statistical Physics

The Large N Expansion In Quantum Field Theory And Statistical Physics

Conformal Field Theory

Integrable Sys Quantum Field Theory

This text provides a thoroughly modern graduate-level introduction to the theory of critical behaviour. It begins with a brief review of phase transitions in simple systems, then goes on to introduce the core ideas of the renormalisation group.

Filling an important gap in the literature, this comprehensive text develops conformal field theory from first principles. The treatment is self-contained, pedagogical, and exhaustive, and includes a great deal of background material on quantum field theory, statistical mechanics, Lie algebras and affine Lie algebras. The many exercises, with a wide spectrum of difficulty and subjects, complement and in many cases extend the text. The text is thus not only an excellent tool for classroom teaching but also for individual study. Intended primarily for graduate students and researchers in theoretical high-energy physics, mathematical physics, condensed matter theory, statistical physics, the book will also be of interest in other areas of theoretical physics and mathematics. It will prepare the reader for original research in this very active field of theoretical and mathematical physics.

Presents recent advances of perturbative relativistic field theory in a pedagogical and straightforward way. For graduate students who intend to specialize in high-energy physics.

An Introduction to Schwinger's Variational Method with Green's Function Nanoapplications, Graphene and Superconductivity

Quantum Field Theory and Condensed Matter

Quantum Field Theory and Statistical Mechanics

With an Introduction to Quantum Field Theory and Numerical Simulation

Master Equations and Fokker-Planck Equations

Methods of Quantum Field Theory in Statistical Physics

This book contains an edited comprehensive collection of reprints on the subject of the large N limit as applied to a wide spectrum of problems in quantum field theory and statistical mechanics. The topics include (1) Spin Systems; (2) Large N Limit of Gauge Theories; (3) Two-Dimensional QCD; (4) Exact Results on Planar Perturbation Series and the Nature of the 1/N Series; (5) Schwinger-Dyson Equations Approach; (6) QCD Phenomenological Lagrangians and the Large N Limit; (7) Other Approaches to Large N: Eguchi-Kawai Model, Collective Fields and Numerical Methods; (8) Matrix Models; (9) Two-Dimensional Gravity and String Theory.

Based on his own work, the author synthesizes the most promising approaches and ideals in field theory today. He presents such subjects as statistical mechanics, quantum field theory and their interrelation, continuous global symmetry, non-Abelian gauge fields, instantons and the quantam theory of loops, and quantum strings and random surfaces. This book is aimed at postgraduate students studying field theory and statistical mechanics, and for research workers in continuous global theory.

This book is devoted to aspects of the foundations of quantum mechanics in which probabilistic and statistical concepts play an essential role. The main part of the book concerns the quantitative statistical theory of quantum measurement, based on the notion of positive operator-valued measures. During the past years there has been substantial progress in this direction, stimulated to a great extent by new applications such as Quantum Optics, Quantum Communication and high-precision experiments. The questions of statistical interpretation, quantum symmetries, theory of canonical

commutation relations and Gaussian states, uncertainty relations as well as new fundamental bounds concerning the accuracy of quantum measurements, are discussed in this book in an accessible yet rigorous way. Compared to the first edition, there is a new Supplement devoted to the hidden variable issue. Comments and the bibliography have also been extended and updated.
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.
Volume II Quantum Field Theory, Statistical Physics and other Modern Applications
Statistical Field Theory: Volume 2, Strong Coupling, Monte Carlo Methods, Conformal Field Theory and Random Systems
Functional Integrals in Quantum Field Theory and Statistical Physics
A Concrete Mathematical Introduction
Non-Perturbative Field Theory
Quantum Theory and Statistical Thermodynamics

 Introduction This volume contains a selection of expository articles on quantum field theory and statistical mechanics by James Glimm and Arthur Jaffe. They include a solution of the original interacting quantum field equations and a description of the physics which these equations contain. Quantum fields were proposed in the late 1920s as the natural framework which combines quantum theory with relativ ity. They have survived ever since.
The path integral approach has proved extremely useful for the understanding of the most complex problems in quantum field theory, cosmology, and condensed matter physics. Path Integrals in Physics: Volume II, Quantum Field Theory, Statistical Physics and other Modern Applications covers the fundamentals of path integrals, both the Wiener and Feynman types, and their many applications in physics. The book deals with systems that have an infinite number of degrees of freedom. It discusses the general physical background and concepts of the path integral approach used, followed by a detailed presentation of the most typical and important applications as well as problems with either their solutions or hints how to solve them. Each chapter is self-contained and can be considered as an independent textbook. It provides a comprehensive, detailed, and systematic account of the subject suitable for both students and experienced researchers.
Specifically written to introduce researchers and advanced students to the modern developments in statistical mechanics and field theory, this book's leitmotiv is functional integration and its application to different areas of physics. The book acts as both an introduction to and a lucid overview of the major problems in statistical field theory.
A thorough and pedagogical introduction to phase transitions and exactly solved models in statistical physics and quantum field theory.
Integrable Systems in Quantum Field Theory and Statistical Mechanics
An Introduction To Quantum Field Theory
Relativistic Many-Body Theory and Statistical Mechanics
Volume 2: Exact, Series and Renormalization Group Methods
Quantum Geometry

Functional integration is one of the most powerful methods of contempo rary theoretical physics, enabling us to simplify, accelerate, and make clearer the process of the theoretician's analytical work. Interest in this method and the endeavour to master it creatively grows incessantly. This book presents a study of the application of functional integration methods to a wide range of contemporary theoretical physics problems. The concept of a functional integral is introduced as a method of quantizing finite-dimensional mechanical systems, as an alternative to ordinary quantum mechanics. The problems of systems quantization with constraints and the manifolds quantization are presented here for the first time in a monograph. The application of the functional integration methods to systems with an infinite number of degrees of freedom allows one to uniquely introduce and formulate the diagram perturbation theory in quantum field theory and statistical physics. This approach is significantly simpler than the widely accepted method using an operator approach.
This is the first of a two-volume presentation on current research problems in quantum optics, and will serve as a standard reference in the field for many years to come. The book provides an introduction to the methods of quantum statistical mechanics used in quantum optics and their application to the quantum theories of the single-mode laser and optical bistability. The generalized representations of Drummond and Gardiner are discussed together with the more standard methods for deriving Fokker-Planck equations.
Providing a systematic introduction to the techniques which are fundamental to quantum field theory, this book pays special attention to the use of these techniques in a wide variety of areas, including ordinary quantum mechanics, quantum mechanics in the second-quantized formulation, relativistic quantum field theory, Euclidean field theory, quant
Providing a broad review of many techniques and their application to condensed matter systems, this book begins with a review of thermodynamics and statistical mechanics, before moving onto real and imaginary time path integrals and the link between Euclidean quantum mechanics and statistical mechanics. A detailed study of the Ising, gauge-Ising and XY models is included. The renormalization group is developed and applied to critical phenomena, Fermi liquid theory and the renormalization of field theories. Next, the book explores bosonization and its applications to one-dimensional fermionic systems and the correlation functions of homogeneous and random-bond Ising models. It concludes with Bohm–Pines and Chern–Simons theories applied to the quantum Hall effect. Introducing the reader to a variety of techniques, it opens up vast areas of condensed matter theory for both graduate students and researchers in theoretical, statistical and condensed matter physics.
Expositions
An Introduction to Exactly Solved Models in Statistical Physics
From Two Dimensional Conformal Field Theory to QCD in Four Dimensions
Spin Glasses and Statistical Mechanics, A Festschrift for Charles M. Newman
Field Theory
Volume 1: From Brownian Motion to Renormalization and Lattice Gauge Theory. Volume 2: Strong Coupling, Monte Carlo Methods, Conformal Field Theory, and Random Systems. This two-volume work provides a comprehensive and timely survey of the application of the methods of quantum field theory to statistical physics, a very active and fruitful area of modern research. The first volume provides a pedagogical introduction to the subject, discussing Brownian motion, its anticommutative counterpart in the guise of Onsager's solution to the two-dimensional Ising model, the mean field or Landau approximation, scaling ideas exemplified by the Kosterlitz-Thouless theory for the XY transition, the continuous renormalization group applied to the standard phi-to the fourth theory (the simplest typical case) and lattice gauge theory as a pathway to the understanding of quark confinement in quantum chromodynamics. The second volume covers more diverse topics, including strong coupling expansions and their analysis, Monte Carlo simulations, two-dimensional conformal field theory, and simple disordered systems. The book concludes with a chapter on random geometry and the Polyakov model of random surfaces which illustrates the relations between string theory and statistical physics. The two volumes that make up this work will be useful to theoretical physicists and applied mathematicians who are interested in the exciting developments which have resulted from the synthesis of field theory and statistical physics.