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Over the past few decades the powerful methods of statistical physics and Euclidean quantum field theory have moved closer together, with common tools based on the use of path integrals. The interpretation of Euclidean field theories as particular systems of statistical physics has opened up new avenues for understanding strongly coupled quantum systems or quantum field theories at zero or finite temperatures. Accordingly, the first chapters of this book contain a self-contained introduction to path integrals in Euclidean quantum mechanics and statistical mechanics. The resulting high-dimensional integrals can be estimated with the help of Monte Carlo simulations based on Markov processes. The most commonly used algorithms are presented in detail so as to prepare the reader for the use of high-performance computers as an “experimental” tool for this burgeoning field of theoretical physics. Several chapters are then devoted to an introduction to simple lattice field theories and a variety of spin systems with discrete and continuous spins, where the ubiquitous Ising model serves as an ideal guide for introducing the fascinating area of phase transitions. As an alternative to the lattice formulation of quantum field theories, variants of the flexible renormalization group methods are discussed in detail. Since, according to our present-day knowledge, all fundamental interactions in nature are described by gauge theories, the remaining chapters of the book deal with gauge theories without and with matter. This text is based on course-tested notes for graduate students and, as such, its style is essentially pedagogical, requiring only some basics of mathematics, statistical physics, and quantum field theory. Yet it also contains some more sophisticated concepts which may be useful to researchers in the field. Each chapter ends with a number of problems – guiding the reader to a deeper understanding of some of the material presented in the main text – and, in most cases, also features some listings of short, useful computer programs.

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Quantum Field Theory and Statistical Mechanics - James Glimm - 2012-12-06
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 relativity. 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
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.

**Elements of Statistical Mechanics** - Ivo Sachs - 2006-05-11

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.

**Functional Integrals in Quantum Field Theory and Statistical Physics** - V.N. Popov - 2001-11-30

Functional integration is one of the most powerful methods of contemporary 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.

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and phase transitions. Other topics include non-perturbative phenomena, anomalies, and conformal invariance. Features numerous examples and extensive problem sets. Also serves as an invaluable resource for researchers.

**Quantum Field Theory** - Eduardo Fradkin - 2021-03-23

The only graduate-level textbook on quantum field theory that fully integrates perspectives from high-energy, condensed-matter, and statistical physics. Quantum field theory was originally developed to describe quantum electrodynamics and other fundamental problems in high-energy physics. But today, it has become an invaluable conceptual and mathematical framework for addressing problems across physics, including in condensed-matter and statistical physics. With this expansion of applications comes a new and deeper understanding of quantum field theory - yet this perspective is still rarely reflected in teaching and textbooks on the subject. Developed from a year-long graduate course Fradkin has taught for years to students of high-energy, condensed-matter, and statistical physics, this comprehensive textbook provides a fully "multicultural" approach to quantum field theory, covering the full breadth of its applications in one volume. Brings together perspectives from high-energy, condensed-matter, and statistical physics in both the main text and exercises. Takes students from basic techniques to the frontiers of physics. Pays special attention to the relation between measurements and propagators and the computation of cross sections and response functions. Focuses on renormalization and the renormalization group, with an emphasis on fixed points, scale invariance, and their role in quantum field theory and phase transitions. Other topics include non-perturbative phenomena, anomalies, and conformal invariance. Features numerous examples and extensive problem sets. Also serves as an invaluable resource for researchers.

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**Quantum Theory as an Emergent Phenomenon** - Stephen L. Adler - 2004-08-26

Although it is one of the most successful physical theories, quantum mechanics raises conceptual issues that have perplexed physicists and philosophers of science for decades. Consider: The wave-particle duality of light and matter. Quantum mechanics treats all physical objects in exactly the same way, and the results are consistent with the facts. But in the macroscopic world, the wave-particle duality vanishes. This is a fundamental problem that has been around for over a century. It is still not solved.

**Statistical Methods in Quantum Field Theory** - Jerzy Hańcikowiak - 1974

Geometric Quantization in Action - N.E. Hurt - 2012-12-06

Approach your problems from the right It is not that they can't see the solution. It end and begin with the answers. Then, is that they can't see the problem. one day, perhaps you will find the final question. G. K. Chesterton, The Scandal of Father Brown 'The Point of a Pin'. 'The Hermit Clad in Crane Feathers' in R. Van Gulik's The Chinese Maze Murders. Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics. However, the 'tree' of knowledge of mathematics and related fields does not grow only by putting forth new branches. It also happens, quite often in fact, that branches which were thought to be completely disparate are suddenly seen to be related. Further, the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years: measure theory is used (non-trivially) in regional and theoretical economics; algebraic geometry interacts with physics; the Minkowsky lemma, coding theory and the structure of water meet one another in packing and covering theory; quantum fields, crystal defects and mathematical programming profit from homotopy theory; Lie algebras are relevant to filtering and prediction and electrical engineering can use Stein spaces.

**Path Integrals in Quantum Mechanics, Statistics, Polymer Physics, and Financial Markets** - Hagen Kleinert - 2009

Topological restrictions. These are relevant to the understanding of the statistical properties of elementary particles and the entanglement phenomena in polymer physics and biophysics. The Chern-Simons theory of particles with fractional statistics (anyons) is introduced and applied to explain the fractional quantum Hall effect. * "The relevance of path integrals to financial markets is discussed, and improvements of the famous Black-Scholes formula for option prices are developed which account for the fact that large market fluctuations occur much more frequently than in Gaussian distributions." --Book Jacket.

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system can be utilized to analyze the properties of the system in an elegant and effective way. It is even possible much more frequently than in Gaussian distributions." --Book jacket.

Relativistic Quantum Fields - Charles Nash - 2010-06-17

"This graduate-level text contains statistical and quantitative techniques for performing calculations in quantum field theory. Topics include renormalization, functional differentiation and integration, and the Schwinger-Dyson equations; dimensional regularization; the gauge and infrared properties of quantum electrodynamics; and asymptotic behavior and renormalization group methods. Reference features include an appendix, bibliography, and index. 1978 edition"--

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Probabilistic Methods in Quantum Field Theory and Quantum Gravity - Poul Henrik Damgaard - 2012-10-31

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Supersymmetric Methods in Quantum and Statistical Physics - Georg Junker - 2012-12-06

The idea of supersymmetry was originally introduced in relativistic quantum field theories as a generalization of Poincare symmetry. In 1976 Nicolai sug gested an analogous generalization for non-relativistic quantum mechanics. With the one-dimensional model introduced by Witten in 1981, supersymmetry became a major tool in quantum mechanics and mathematical, sta tistical, and condensed-III.l. ter physics. Supersymmetry is also a successful concept in nuclear and atomic physics. An underlying supersymmetry of a given quantum-mechanical to obtain exact results thanks to supersymmetry. The purpose of this book is to give an introduction to supersymmetricic quantum mechanics and review some of the recent developments of vari anasymmetrizations in quantum and statistical physics. Thereby we will touch upon some topics related to mathematical and condensed-matter physics. A discussion of supersymmetry in atomic and nuclear physics is omit ted. However, the reader will find some references in Chap. 9. Similarly, super symmetric field theories and supergravity are not considered in this book. In fact, there exist already many excellent textbooks and monographs on these topics. A list may be found in Chap. 9. Yet, it is hoped that this book may be useful in preparing a footing for a study of supersymmetric theories in atomic, nuclear, and particle physics. The plan of the book is as follows.

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Introductory Applied Quantum and Statistical Mechanics - Peter L. Hagelstein - 2004-03-25

* An applied focus for electrical engineers and materials scientists. * Theoretical results supported with real-world systems and applications. * Includes worked examples and self-study questions. * Solutions manual available.

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Path Integrals in Physics - M Chaichian - 2001-07-01

This book provides an ideal introduction to the use of Feynman path integrals in the fields of quantum mechanics and statistical physics. It is written for graduate students and researchers in physics, mathematical physics, applied mathematics as well as chemistry. The material is presented in an accessible manner for readers with little knowledge of quantum mechanics and no prior exposure to path integrals. It begins with elementary concepts and a review of quantum mechanics that gradually builds the framework for the Feynman path integrals and how they are applied to problems in quantum mechanics and statistical physics. Problem sets throughout the book allow readers to test their understanding and reinforce the explanations of the theory in real situations. Features: Comprehensive and rigorous yet, presents an easy-to-understand approach. Applicable to a wide range of disciplines. Accessible to those with little, or basic, mathematical understanding.

Feynman Path Integrals in Quantum Mechanics and Statistical Physics - Lukong Cornelius Pai - 2021-04-16

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Recent Progress in Statistical Mechanics and Quantum Field Theory - H Saleur - 1995-08-31

The following topics were covered: the study of renormalization group flows between field theories using the methods of quantum integrability, S-matrix theory and the thermodynamic Bethe Ansatz; impurity problems approached both from the point of view of conformal field theory and quantum integrability. This includes the Kondo effect and quantum wires; solvable models with 1/\(n\) interactions (Haldane-Shastri models). Yangian symmetries in 1/r² models and in conformal field theories; correlation functions in integrable 1+1 field theories; integrability in three dimensions; conformal invariance and the quantum hall effect; supersymmetry in statistical mechanics; and relations to two-dimensional Yang-Mills and QCD.

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