

Sethna Statistical Mechanics Complexity Solution

There has been recently some interdisciplinary convergence on a number of precise topics which can be considered as prototypes of complex systems. This convergence is best appreciated at the level of the techniques needed to deal with these systems, which include: 1) A domain of research around a multiple point where statistical physics, information theory, algorithmic computer science, and more theoretical (probabilistic) computer science meet: this covers some aspects of error correcting codes, stochastic optimization algorithms, typical case complexity and phase transitions, constraint satisfaction problems. 2) The study of collective behavior of interacting agents, its impact on understanding some types of economical and financial problems, their link to population and epidemics dynamics, game theory, social, biological and computer networks and evolution. The present book is the written version of the lectures given during the Les Houches summer school session on "Complex Systems", devoted to these emerging interdisciplinary fields. The lectures consist both in a number of long methodological courses (probability theory, statistical physics of disordered systems, information theory, network structure and evolution, agent-based economics and numerical methods) and more specific, 'problem oriented' courses. Lecturers are all leading experts in their field; they have summarized recent results in a clear and authoritative manner. The "Les Houches lecture notes" have a long tradition of excellence and are often found to be useful for a number of years after they were written. The book is of interest to students and researchers with various backgrounds: probability theory, computer science, information theory, physics, finance, biology, etc. - Topical

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and comprehensive survey of the emerging, interdisciplinary field of "Complex Systems", covered by recognized world experts · "Les Houches lectures notes": a long tradition of excellence and long-lasting impact · Of interest to a broad audience (mathematics, physics, biology, informatics, finance, geology, etc.) · Some applications may have concrete impact · Selected topics in complex systems: forefront of research in the field

This self-contained text describes the modern mean field theory of simple structural glasses using a quantum statistical mechanical approach. Describing the theory in clear and simple terms, this is a valuable resource for graduate students and researchers working in condensed matter physics and statistical mechanics.

From controlling disease outbreaks to predicting heart attacks, dynamic models are increasingly crucial for understanding biological processes. Many universities are starting undergraduate programs in computational biology to introduce students to this rapidly growing field. In *Dynamic Models in Biology*, the first text on dynamic models specifically written for undergraduate students in the biological sciences, ecologist Stephen Ellner and mathematician John Guckenheimer teach students how to understand, build, and use dynamic models in biology. Developed from a course taught by Ellner and Guckenheimer at Cornell University, the book is organized around biological applications, with mathematics and computing developed through case studies at the molecular, cellular, and population levels. The authors cover both simple analytic models--the sort usually found in mathematical biology texts--and the complex computational models now used by both biologists and mathematicians. Linked to a Web site with computer-lab materials and exercises, *Dynamic Models in Biology* is a major new introduction to dynamic models for

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students in the biological sciences, mathematics, and engineering.

An introductory text providing the reader with a thorough background to the rich world of applications of stochastic processes.

Statistical Physics and Information Theory is a succinct in-depth review and tutorial of a subject that promises to lead to major advances in computer and communication security. The only text to cover both thermodynamic and statistical mechanics--allowing students to fully master thermodynamics at the macroscopic level. Presents essential ideas on critical phenomena developed over the last decade in simple, qualitative terms. This new edition maintains the simple structure of the first and puts new emphasis on pedagogical considerations. Thermostatistics is incorporated into the text without eclipsing macroscopic thermodynamics, and is integrated into the conceptual framework of physical theory. The main body of this book is devoted to statistical physics, whereas much less emphasis is given to thermodynamics. In particular, the idea is to present the most important outcomes of thermodynamics – most notably, the laws of thermodynamics – as conclusions from derivations in statistical physics. Special emphasis is on subjects that are vital to engineering education. These include, first of all, quantum statistics, like the Fermi-Dirac distribution, as well as diffusion processes, both of which are fundamental to a sound understanding of semiconductor devices. Another important issue for electrical engineering students is understanding of the mechanisms of noise generation and stochastic dynamics in physical systems, most notably in electric circuitry. Accordingly, the fluctuation-dissipation theorem of statistical mechanics, which is the theoretical basis for understanding thermal noise processes in systems, is presented from a signals-and-systems point of view, in a

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way that is readily accessible for engineering students and in relation with other courses in the electrical engineering curriculum, like courses on random processes.

One common feature of new emerging technologies is the fusion of the very small (nano) scale and the large scale engineering. The classical environment provided by single scale theories, as for instance by the classical hydrodynamics, is not anymore satisfactory. The main challenge is to keep the important details while still be able to keep the overall picture and simplicity. It is the thermodynamics that addresses this challenge. Our main reason for writing this book is to explain such general viewpoint of thermodynamics and to illustrate it on a very wide range of examples. Contents Levels of description Hamiltonian mechanics Irreversible evolution Reversible and irreversible evolution Multicomponent systems Contact geometry Appendix: Mathematical aspects

Complex systems that bridge the traditional disciplines of physics, chemistry, biology, and materials science can be studied at an unprecedented level of detail using increasingly sophisticated theoretical methodology and high-speed computers. The aim of this book is to prepare burgeoning users and developers to become active participants in this exciting and rapidly advancing research area by uniting for the first time, in one monograph, the basic concepts of equilibrium and time-dependent statistical mechanics with the modern techniques used to solve the complex problems that arise in real-world applications. The book contains a detailed review of classical and quantum mechanics, in-depth discussions of the most commonly used ensembles simultaneously with modern computational techniques such as molecular dynamics and Monte Carlo, and important topics including free-energy calculations, linear-response theory, harmonic baths and the generalized Langevin equation,

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critical phenomena, and advanced conformational sampling methods. Burgeoning users and developers are thus provided firm grounding to become active participants in this exciting and rapidly advancing research area, while experienced practitioners will find the book to be a useful reference tool for the field.

An important task of theoretical quantum physics is the building of idealized mathematical models to describe the properties of quantum matter. This book provides an introduction to the arguably most important method for obtaining exact results for strongly interacting models of quantum matter - the Bethe ansatz. It introduces and discusses the physical concepts and mathematical tools used to construct realistic models for a variety of different fields, including condensed matter physics and quantum optics. The various forms of the Bethe ansatz - algebraic, coordinate, multicomponent, and thermodynamic Bethe ansatz, and Bethe ansatz for finite systems - are then explained in depth and employed to find exact solutions for the physical properties of the integrable forms of strongly interacting quantum systems. The Bethe ansatz is one of the very few methodologies which can calculate physical properties non-perturbatively. Arguably, it is the only such method we have which is exact. This means, once the model has been set up, no further approximations or assumptions are necessary, and the relevant physical properties of the model can be computed exactly. Furthermore, an infinite set of conserved quantities can be obtained. The quantum mechanical model under consideration is fully integrable. This makes the search for quantum models which are amenable to an exact solution by the Bethe ansatz, and which are quantum integrable, so important and rewarding. The exact solution will provide benchmarks for other models, which do not admit an exact solution. Bethe ansatz techniques provide valuable insight

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into the physics of strongly correlated quantum matter. At its core, information security deals with the secure and accurate transfer of information. While information security has long been important, it was, perhaps, brought more clearly into mainstream focus with the so-called "Y2K" issue. The Y2K scare was the fear that computer networks and the systems that are controlled or operated by software would fail with the turn of the millennium, since their clocks could lose synchronization by not recognizing a number (instruction) with three zeros. A positive outcome of this scare was the creation of several Computer Emergency Response Teams (CERTs) around the world that now work - operatively to exchange expertise and information, and to coordinate in case major problems should arise in the modern IT environment. The terrorist attacks of 11 September 2001 raised security concerns to a new level. The international community responded on at least two fronts; one front being the transfer of reliable information via secure networks and the other being the collection of information about potential terrorists. As a sign of this new emphasis on security, since 2001, all major academic publishers have started technical journals focused on security, and every major communications conference (for example, Globecom and ICC) has organized workshops and sessions on security issues. In addition, the IEEE has created a technical committee on Communication and Information Security. The first editor was intimately involved with security for the Athens Olympic Games of 2004.

Sethna's book distills the core ideas of statistical mechanics to make room for new advances important to information theory, complexity, and modern biology. Aimed at advanced undergraduates and early graduate students, Sethna's text explores everything from chaos through information theory to life at the end of the universe.

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room for new advances important to information theory, complexity, and modern biology. He explores everything from chaos through to life at the end of the universe.

Statistical Mechanics discusses the fundamental concepts involved in understanding the physical properties of matter in bulk on the basis of the dynamical behavior of its microscopic constituents. The book emphasizes the equilibrium states of physical systems. The text first details the statistical basis of thermodynamics, and then proceeds to discussing the elements of ensemble theory. The next two chapters cover the canonical and grand canonical ensemble. Chapter 5 deals with the formulation of quantum statistics, while Chapter 6 talks about the theory of simple gases. Chapters 7 and 8 examine the ideal Bose and Fermi systems. In the next three chapters, the book covers the statistical mechanics of interacting systems, which includes the method of cluster expansions, pseudopotentials, and quantized fields. Chapter 12 discusses the theory of phase transitions, while Chapter 13 discusses fluctuations. The book will be of great use to researchers and practitioners from wide array of disciplines, such as physics, chemistry, and engineering.

Statistical Mechanics Entropy, Order Parameters and Complexity OUP Oxford

Statistical physics has its origins in attempts to describe the thermal properties of matter in terms of its constituent particles, and has played a fundamental role in the development of quantum mechanics. Based on lectures taught by Professor Kardar at MIT, this textbook introduces the central concepts and tools of statistical physics. It contains a chapter on probability and related issues such as the central limit theorem and information theory, and covers interacting particles, with an extensive description of the van der Waals equation and its derivation by mean field approximation. It also contains an integrated set of problems,

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with solutions to selected problems at the end of the book and a complete set of solutions is available to lecturers on a password protected website at www.cambridge.org/9780521873420. A companion volume, *Statistical Physics of Fields*, discusses non-mean field aspects of scaling and critical phenomena, through the perspective of renormalization group.

The book aims to explain the basic ideas of thermal physics intuitively and in the simplest possible way. It is aimed at making the reader feel comfortable with the ideas of entropy and free energy. Thermal physics is prone to misunderstanding, confusion and is often being overlooked. However, a good foundation is necessary to prepare the reader for advanced level studies.

This textbook covers the basic principles of statistical physics and thermodynamics. The text is pitched at the level equivalent to first-year graduate studies or advanced undergraduate studies. It presents the subject in a straightforward and lively manner. After reviewing the basic probability theory of classical thermodynamics, the author addresses the standard topics of statistical physics. The text demonstrates their relevance in other scientific fields using clear and explicit examples. Later chapters introduce phase transitions, critical phenomena and non-equilibrium phenomena.

This full-colour undergraduate textbook, based on a two semester course, presents the fundamentals of biological physics, introducing essential modern topics that include cells, polymers, polyelectrolytes, membranes, liquid crystals, phase transitions, self-assembly, photonics, fluid mechanics, motility, chemical kinetics, enzyme

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kinetics, systems biology, nerves, physiology, the senses, and the brain. The comprehensive coverage, featuring in-depth explanations of recent rapid developments, demonstrates this to be one of the most diverse of modern scientific disciplines. The *Physics of Living Processes: A Mesoscopic Approach* is comprised of five principal sections: • Building Blocks • Soft Condensed Matter Techniques in Biology • Experimental Techniques • Systems Biology • Spikes, Brains and the Senses The unique focus is predominantly on the mesoscale — structures on length scales between those of atoms and the macroscopic behaviour of whole organisms. The connections between molecules and their emergent biological phenomena provide a novel integrated perspective on biological physics, making this an important text across a variety of scientific disciplines including biophysics, physics, physical chemistry, chemical engineering and bioengineering. An extensive set of worked tutorial questions are included, which will equip the reader with a range of new physical tools to approach problems in the life sciences from medicine, pharmaceutical science and agriculture.

Building on the material learned by students in their first few years of study, *Topics in Statistical Mechanics (Second Edition)* presents an advanced level course on statistical and thermal physics. It begins with a review of the formal structure of statistical mechanics and thermodynamics considered from a unified viewpoint. There is a brief revision of non-interacting systems, including quantum gases and a discussion of negative temperatures. Following this, emphasis is on interacting

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systems. First, weakly interacting systems are considered, where the interest is in seeing how small interactions cause small deviations from the non-interacting case. Second, systems are examined where interactions lead to drastic changes, namely phase transitions. A number of specific examples is given, and these are unified within the Landau theory of phase transitions. The final chapter of the book looks at non-equilibrium systems, in particular the way they evolve towards equilibrium. This is framed within the context of linear response theory. Here fluctuations play a vital role, as is formalised in the fluctuation-dissipation theorem. The second edition has been revised particularly to help students use this book for self-study. In addition, the section on non-ideal gases has been expanded, with a treatment of the hard-sphere gas, and an accessible discussion of interacting quantum gases. In many cases there are details of Mathematica calculations, including Mathematica Notebooks, and expression of some results in terms of Special Functions. This book addresses problems in three main developments in modern condensed matter physics—namely topological superconductivity, many-body localization and strongly interacting condensates/superfluids—by employing fruitful analogies from classical mechanics. This strategy has led to tangible results, firstly in superconducting nanowires: the density of states, a smoking gun for the long sought Majorana zero mode is calculated effortlessly by mapping the problem to a textbook-level classical point particle problem. Secondly, in localization theory even

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the simplest toy models that exhibit many-body localization are mathematically cumbersome and results rely on simulations that are limited by computational power. In this book an alternative viewpoint is developed by describing many-body localization in terms of quantum rotors that have incommensurate rotation frequencies, an exactly solvable system. Finally, the fluctuations in a strongly interacting Bose condensate and superfluid, a notoriously difficult system to analyze from first principles, are shown to mimic stochastic fluctuations of space-time due to quantum fields. This analogy not only allows for the computation of physical properties of the fluctuations in an elegant way, it sheds light on the nature of space-time. The book will be a valuable contribution for its unifying style that illuminates conceptually challenging developments in condensed matter physics and its use of elegant mathematical models in addition to producing new and concrete results.

Based on lectures given by one of the authors with many years of experience in teaching stochastic processes, this textbook is unique in combining basic mathematical and physical theory with numerous simple and sophisticated examples as well as detailed calculations. In addition, applications from different fields are included so as to strengthen the background learned in the first part of the book. With its exercises at the end of each chapter (and solutions only available to lecturers) this book will benefit students and researchers at different educational levels. Solutions manual available for lecturers on www.wiley-vch.de

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In each generation, scientists must redefine their fields: abstracting, simplifying and distilling the previous standard topics to make room for new advances and methods. Sethna's book takes this step for statistical mechanics - a field rooted in physics and chemistry whose ideas and methods are now central to information theory, complexity, and modern biology. Aimed at advanced undergraduates and early graduate students in all of these fields, Sethna limits his main presentation to the topics that future mathematicians and biologists, as well as physicists and chemists, will find fascinating and central to their work. The amazing breadth of the field is reflected in the author's large supply of carefully crafted exercises, each an introduction to a whole field of study: everything from chaos through information theory to life at the end of the universe.

The book provides an introduction to the physics which underlies phase transitions and to the theoretical techniques currently at our disposal for understanding them. It will be useful for advanced undergraduates, for post-graduate students undertaking research in related fields, and for established researchers in experimental physics, chemistry, and metallurgy as an exposition of current theoretical understanding. - ;Recent developments have led to a good understanding of universality; why phase transitions in systems as diverse as magnets, fluids, liquid crystals, and superconductors can be brought under the same theoretical umbrella and well described by simple models. This book describes the physics underlying universality and then lays out the theoretical approaches now available for studying phase

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transitions. Traditional techniques, mean-field theory, series expansions, and the transfer matrix, are described; the Monte Carlo method is covered, and two chapters are devoted to the renormalization group, which led to a break-through in the field. The book will be useful as a textbook for a course in 'Phase Transitions', as an introduction for graduate students undertaking research in related fields, and as an overview for scientists in other disciplines who work with phase transitions but who are not aware of the current tools in the armoury of the theoretical physicist. - ;Introduction; Statistical mechanics and thermodynamics; Models; Mean-field theories; The transfer matrix; Series expansions; Monte Carlo simulations; The renormalization group; Implementations of the renormalization group. -

As an introductory account of the theory of phase transitions and critical phenomena, this book reflects lectures given by the authors to graduate students at their departments and is thus classroom-tested to help beginners enter the field. Most parts are written as self-contained units and every new concept or calculation is explained in detail without assuming prior knowledge of the subject. The book significantly enhances and revises a Japanese version which is a bestseller in the Japanese market and is considered a standard textbook in the field. It contains new pedagogical presentations of field theory methods, including a chapter on conformal field theory, and various modern developments hard to find in a single textbook on phase transitions. Exercises are presented as the topics develop, with solutions found at

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the end of the book, making the text useful for self-teaching, as well as for classroom learning.

This book contains the latest information on all aspects of the most important chemical thermodynamic properties of Gibbs energy and Helmholtz energy, as related to fluids. Both the Gibbs energy and Helmholtz energy are very important in the fields of thermodynamics and material properties as many other properties are obtained from the temperature or pressure dependence. Bringing all the information into one authoritative survey, the book is written by acknowledged world experts in their respective fields. Each of the chapters will cover theory, experimental methods and techniques and results for all types of liquids and vapours. This book is the fourth in the series of Thermodynamic Properties related to liquids, solutions and vapours, edited by Emmerich Wilhelm and Trevor Letcher. The previous books were: Heat Capacities (2010), Volume Properties (2015), and Enthalpy (2017). This book fills the gap in fundamental thermodynamic properties and is the last in the series.

This book describes how the arrangement and movement of atoms in a solid are related to the forces between atoms, and how they affect the behaviour and properties of materials. The book is intended for final year undergraduate students and graduate students in physics and materials science.

Statistical mechanics is one of the most exciting areas of physics today, and it also has applications to subjects as diverse as economics, social behavior, algorithmic theory, and evolutionary biology. Statistical Mechanics in

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a Nutshell offers the most concise, self-contained introduction to this rapidly developing field. Requiring only a background in elementary calculus and elementary mechanics, this book starts with the basics, introduces the most important developments in classical statistical mechanics over the last thirty years, and guides readers to the very threshold of today's cutting-edge research. Statistical Mechanics in a Nutshell zeroes in on the most relevant and promising advances in the field, including the theory of phase transitions, generalized Brownian motion and stochastic dynamics, the methods underlying Monte Carlo simulations, complex systems--and much, much more. The essential resource on the subject, this book is the most up-to-date and accessible introduction available for graduate students and advanced undergraduates seeking a succinct primer on the core ideas of statistical mechanics. Provides the most concise, self-contained introduction to statistical mechanics Focuses on the most promising advances, not complicated calculations Requires only elementary calculus and elementary mechanics Guides readers from the basics to the threshold of modern research Highlights the broad scope of applications of statistical mechanics

Volume 5.

This book is an introduction to statistical mechanics, intended for advanced undergraduate or beginning graduate students.

Accompanying disc contains Powerpoint slides, animations and texts in various formats.

This text provides a quantitative introduction to general

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relativity for advanced undergraduate and graduate students.

This book constitutes the refereed proceedings of the 14th International Conference on Unconventional Computation and Natural Computation, UCNC 2015, held in Auckland, New Zealand, in August/September 2015. The 16 revised full papers were carefully reviewed and selected from 38 submissions. The papers cover a wide range of topics including among others molecular (DNA) computing; quantum computing; optical computing; chaos computing; physarum computing; computation in hyperbolic spaces; collision-based computing; cellular automata; neural computation; evolutionary computation; swarm intelligence; nature-inspired algorithms; artificial immune systems; artificial life; membrane computing; amorphous computing; computational systems biology; genetic networks; protein-protein networks; transport networks; synthetic biology; cellular (in vivo) computing; and computations beyond the Turing model and philosophical aspects of computing.

Soft matter (polymers, colloids, surfactants, liquid crystals) are an important class of materials for modern and future technologies. They are complex materials that behave neither like a fluid nor a solid. This book describes the characteristics of such materials and how we can understand such characteristics in the language of physics.

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A new and updated edition of the successful *Statistical Mechanics: Entropy, Order Parameters and Complexity* from 2006. Statistical mechanics is a core topic in modern physics. Innovative, fresh introduction to the broad range of topics of statistical mechanics today, by brilliant teacher and renowned researcher.

Statistical mechanics is the theory underlying condensed matter physics. This book outlines the theory in a simple and progressive way, at a level suitable for undergraduates. New to this edition are three chapters on phase transitions, which is now included in undergraduate courses. There are plenty of problems at the end of each chapter, and brief model answers are provided for odd-numbered problems.

This volume contains the proceedings of the Conference on Mathematics and its Applications-2014, held from November 14-17, 2014, at Kuwait University, Safat, Kuwait. Papers contained in this volume cover various topics in pure and applied mathematics ranging from an introductory study of quotients and homomorphisms of C -systems, also known as contextual pre-categories, to the most important consequences of the so-called Fokas method. Also covered are multidisciplinary topics such as new structural and spectral matricial results, acousto-electromagnetic tomography method, a recent hybrid imaging

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technique, some numerical aspects of sonic-boom minimization, PDE eigenvalue problems, von Neumann entropy in graph theory, the relative entropy method for hyperbolic systems, conductances on grids, inverse problems in magnetohydrodynamics, location and size estimation of small rigid bodies using elastic far-fields, and the space-time fractional Schrödinger equation, just to cite a few. Papers contained in this volume cover various topics in pure and applied mathematics ranging from an introductory study of quotients and homomorphisms of C -systems, also known as contextual pre-categories, to the most important consequences of the so-called Fokas method. Also covered are multidisciplinary topics such as new structural and spectral matricial results, acousto-electromagnetic tomography method, a recent hybrid imaging technique, some numerical aspects of sonic-boom minimization, PDE eigenvalue problems, von Neumann entropy in graph theory, the relative entropy method for hyperbolic systems, conductances on grids, inverse problems in magnetohydrodynamics, location and size estimation of small rigid bodies using elastic far-fields, and the space-time fractional Schrödinger equation, just to cite a few. - See more at: <http://s350148651-preview.tizrapublisher.com/conm-658/#sthash.74nRhV3y.dpuf> This volume contains the proceedings of the Conference on Mathematics and its

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Applications—2014, held from November 14–17, 2014, at Kuwait University, Safat, Kuwait. - See more at: <http://s350148651-preview.tizrapublisher.com/conm-658/#sthash.74nRhV3y.dpuf>

This book discusses the computational approach in modern statistical physics, adopting simple language and an attractive format of many illustrations, tables and printed algorithms. The discussion of key subjects in classical and quantum statistical physics will appeal to students, teachers and researchers in physics and related sciences. The focus is on orientation with implementation details kept to a minimum. - ;This book discusses the computational approach in modern statistical physics in a clear and accessible way and demonstrates its close relation to other approaches in theoretical physics. Individual chapters focus on subjects as diverse as the hard sphere liquid, classical spin models, single quantum particles and Bose-Einstein condensation. Contained within the chapters are in-depth discussions of algorithms, ranging from basic enumeration methods to modern Monte Carlo techniques. The emphasis is on orientation, with discussion of implementation details kept to a minimum. Illustrations, tables and concise printed algorithms convey key information, making the material very accessible. The book is completely self-contained and graphs and tables can readily be reproduced, requiring minimal computer code. Most sections begin at an elementary level

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and lead on to the rich and difficult problems of contemporary computational and statistical physics. The book will be of interest to a wide range of students, teachers and researchers in physics and the neighbouring sciences. An accompanying CD allows incorporation of the book's content (illustrations, tables, schematic programs) into the reader's own presentations. - ;'This book is the best one I have reviewed all year.' Alan Hinchliffe, Physical Sciences Educational Reviews -
A self-contained, mathematical introduction to the driving ideas in equilibrium statistical mechanics, studying important models in detail.

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