Phase Transitions And Critical Phenomena Volume 19

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 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. - First published in 1971, this highly popular text is devoted to the interdisciplinary area of critical phenomena, with an emphasis on liquid-gas and ferromagnetic transitions. Advanced undergraduate and graduate students in thermodynamics, statistical mechanics, and solid state physics, as well as researchers in physics, mathematics, chemistry, and materials science, will welcome this paperback edition of Stanley's acclaimed text.

During a century, from the Van der Waals mean field description (1874) of gases to the introduction of renormalization group (RG techniques 1970), thermodynamics and statistical physics were just unable to account for the incredible universality which was observed in numerous critical phenomena. The great success of RG techniques is not only to solve perfectly this challenge of critical behaviour in thermal transitions but to introduce extremely useful tools in a wide field of daily situations where a system exhibits scale invariance. The introduction of scaling, scale invariance and universality concepts has been a significant turn in modern physics and more generally in natural sciences. Since

then, a new "physics of scaling laws and critical exponents", rooted in scaling approaches, allows quantitative descriptions of numerous phenomena, ranging from phase transitions to earthquakes, polymer conformations, heartbeat rhythm, diffusion, interface growth and roughening, DNA sequence, dynamical systems, chaos and turbulence. The chapters are jointly written by an experimentalist and a theorist. This book aims at a pedagogical overview, offering to the students and researchers a thorough conceptual background and a simple account of a wide range of applications. It presents a complete tour of both the formal advances and experimental results associated with the notion of scaling, in physics, chemistry and biology.

A brand-new conceptual look at dynamical thermodynamics This book merges the two universalisms of thermodynamics and dynamical systems theory in a single compendium, with the latter providing an ideal language for the former, to develop a new and unique framework for dynamical thermodynamics. In particular, the book uses system-theoretic ideas to bring coherence, clarity, and precision to an important and poorly understood classical area of science. The dynamical systems formalism captures all of the key aspects of thermodynamics, including its fundamental laws, while providing a mathematically rigorous formulation for thermodynamical systems out of equilibrium by unifying the theory

of mechanics with that of classical thermodynamics. This book includes topics on nonequilibrium irreversible thermodynamics, Boltzmann thermodynamics, mass-action kinetics and chemical reactions, finite-time thermodynamics, thermodynamic critical phenomena with continuous and discontinuous phase transitions, information theory, continuum and stochastic thermodynamics, and relativistic thermodynamics. A Dynamical Systems Theory of Thermodynamics develops a postmodern theory of thermodynamics as part of mathematical dynamical systems theory. The book establishes a clear nexus between thermodynamic irreversibility, the second law of thermodynamics, and the arrow of time to further unify discreteness and continuity, indeterminism and determinism, and quantum mechanics and general relativity in the pursuit of understanding the most fundamental property of the universe—the entropic arrow of time.

Readership: Physicists, chemists, mathematicians, postgraduates and undergraduates. Keywords:Phase Transitions;Critical Phenomena;Bogolubov;Quasi-Averages

This book provides a comprehensive introduction to the theory of phase transitions and critical phenomena. The content covers a period of more than 100 years of theoretical research of condensed matter phases and phase transitions

providing a clear interrelationship with experimental problems. It starts from certain basic University knowledge of thermodynamics, statistical physics and quantum mechanics. The text is illustrated with classic examples of phase transitions. Various types of phase transition and (multi)critical points are introduced and explained. The classic aspects of the theory are naturally related with the modern developments. This interrelationship and the field-theoretical renormalization group method are presented in details. The main applications of the renormalization group methods are presented. Special attention is paid to the description of quantum phase transitions. This edition contains a more detailed presentation of the renormalization group method and its applications to particular systems.

The successful calculation of critical exponents for continuous phase transitions is one of the main achievements of theoretical physics over the last quarter-century. This was achieved through the use of scaling and field-theoretic techniques which have since become standard equipment in many areas of physics, especially quantum field theory. This book provides a thorough introduction to these techniques. Continuous phase transitions are introduced, then the necessary statistical mechanics is summarized, followed by standard models, some exact solutions and techniques for numerical simulations. The real-space renormalization group and mean-field theory are then explained and illustrated. The final chapters cover the Landau-Ginzburg model, from physical motivation, through diagrammatic perturbation theory and

renormalization to the renormalization group and the calculation of critical exponents above and below the critical temperature.

This book reviews some of the classic aspects in the theory of phase transitions and critical phenomena, which has a long history. Recently, these aspects are attracting much attention due to essential new contributions. The topics presented in this book include: mathematical theory of the Ising model; equilibrium and non-equilibrium criticality of one-dimensional quantum spin chains; influence of structural disorder on the critical behaviour of the Potts model; criticality, fractality and multifractality of linked polymers; field-theoretical approaches in the superconducting phase transitions. The book is based on the review lectures that were given in Lviv (Ukraine) in March 2002 at the "Ising lectures" — a traditional annual workshop on phase transitions and critical phenomena which aims to bring together scientists working in the field of phase transitions with university students and those who are interested in the subject. Contents:Mathematical Theory of the Ising Model and Its Generalizations: An Introduction (Y Kozitsky)Relaxation in Quantum Spin Chains: Free Fermionic Models (D Karevski)Quantum Phase Transitions in Alternating Transverse Ising Chains (O Derzhko)Phase Transitions in Two-Dimensional Random Potts Models (B Berche & C Chatelain)Scaling of Miktoarm Star Polymers (C von Ferber)Field Theoretic Approaches to the Superconducting Phase Transition (F S Nogueira & H Kleinert) Readership: Researchers, academics and graduate students in condensed matter physics. Keywords:Phase Transitions;Disorder;Critical Phenomena;Renormalization Group;Ising Model;Potts Model

This volume provides a compact presentation of modern statistical physics at an advanced level, from the foundations of statistical mechanics to the main modern applications of

statistical physics. Special attention is given to new approaches, such as quantum field theory methods and non-equilibrium problems. This second, revised edition is expanded with biographical notes contextualizing the main results in statistical physics.

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.

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

Over the past few years, finite-size scaling has become an increasingly important tool in studies of critical systems. This is partly due to an increased understanding of finite-size effects by analytical means, and partly due to our ability to treat larger systems with large computers. The aim of this volume was to collect those papers which have been important for this progress and which illustrate novel applications of the method. The emphasis has been placed on relatively recent developments, including the use of the &egr;-expansion and of conformal

methods.

This book is based on research carried out by the author in close collabora tion with a number of colleagues. In particular, I wish to thank Per Bak, A. John Berlinsky, Hans C. Fogedby, Barry Frank, S. 1. Knak Jensen, David Mukamel, David Pink, and Martin Zuckermann for fruitful and extremely stimulating cooperation. It is a pleasure for me to note that active interaction with most of these colleagues is still continuing. The work has been performed at several different institutions, notably the Department of Chemistry, Aarhus University, Denmark, and the Depart ment of Physics, University of British Columb~a, Canada. I wish to thank the Department of Chemistry at Aarhus University for providing me with splen did research facilities over the years. From May 1980 to August 1981, I visited the Department of Physics at the University of British Columbia and I would like to express my sincere gratitude to members ofthe department for provi ding me with excellent working conditions. My special thanks are due to Professor Myer Bloom who introduced me to the field of phase transitions in biological membranes and in whose biomembrane group I found an extre mely stimulating scientific atmosphere happily married with a most agreeable social climate. During the last two years when a major part ofthis work was carried out, I was supported by AIS De Danske Spritfabrikker through their Jubilreumsle gat of 1981. Their support is gratefully acknowledged.

The field of phase transitions and critical phenomena continues to be active in

research, producing a steady stream of interesting and fruitful results. No longer an area of specialist interest, it has acquired a central focus in condensed matter studies. The major aim of this serial is to provide review articles that can serve as standard references for research workers in the field, and for graduate students and others wishing to obtain reliable information on important recent developments. The two review articles in this volume complement each other in a remarkable way. Both deal with what might be called the modern geometric approach to the properties of macroscopic systems. The first article by Georgii (et al.) describes how recent advances in the application of geometric ideas leads to a better understanding of pure phases and phase transitions in equilibrium systems. The second article by Alava (et al.) deals with geometrical aspects of multi-body systems in a hands-on way, going beyond abstract theory to obtain practical answers. The combination of computers and geometrical ideas described in this volume will doubtless play a major role in the development of statistical mechanics in the twenty-first century.

Critical phenomena is one of the most exciting areas of modern physics. This 2007 book provides a thorough but economic introduction into the principles and techniques of the theory of critical phenomena and the renormalization group, from the perspective of modern condensed matter physics. Assuming basic knowledge of quantum and statistical mechanics, the book discusses phase transitions in magnets, superfluids, superconductors, and gauge field theories. Particular attention is given to topics such

as gauge field fluctuations in superconductors, the Kosterlitz-Thouless transition, duality transformations, and quantum phase transitions - all of which are at the forefront of physics research. This book contains numerous problems of varying degrees of difficulty, with solutions. These problems provide readers with a wealth of material to test their understanding of the subject. It is ideal for graduate students and more experienced researchers in the fields of condensed matter physics, statistical physics, and many-body physics.

The eigenvalue densities in various matrix models in quantum chromodynamics (QCD) are ultimately unified in this book by a unified model derived from the integrable systems. Many new density models and free energy functions are consequently solved and presented. The phase transition models including critical phenomena with fractional power-law for the discontinuities of the free energies in the matrix models are systematically classified by means of a clear and rigorous mathematical demonstration. The methods here will stimulate new research directions such as the important Seiberg-Witten differential in Seiberg-Witten theory for solving the mass gap problem in quantum Yang-Mills theory. The formulations and results will benefit researchers and students in the fields of phase transitions, integrable systems, matrix models and Seiberg-Witten theory.

Phase transition dynamics is centrally important to condensed matter physics. This 2002 book treats a wide variety of topics systematically by constructing time-dependent

Ginzburg-Landau models for various systems in physics, metallurgy and polymer science. Beginning with a summary of advanced statistical-mechanical theories including the renormalization group theory, the book reviews dynamical theories, and covers the kinetics of phase ordering, spinodal decomposition and nucleation in depth. The phase transition dynamics of real systems are discussed, treating interdisciplinary problems in a unified manner. Topics include supercritical fluid dynamics, stress-diffusion coupling in polymers and mesoscopic dynamics at structural phase transitions in solids. Theoretical and experimental approaches to shear flow problems in fluids are reviewed. Phase Transition Dynamics provides a comprehensive account, building on the statistical mechanics of phase transitions covered in many introductory textbooks. It will be essential reading for researchers and advanced graduate students in physics, chemistry, metallurgy and polymer science.

A Primer to the Theory of Critical Phenomena provides scientists in academia and industry, as well as graduate students in physics, chemistry, and geochemistry with the scientific fundamentals of critical phenomena and phase transitions. The book helps readers broaden their understanding of a field that has developed tremendously over the last forty years. The book also makes a great resource for graduate level instructors at universities. Provides a thorough and accessible treatment of the fundamentals of critical phenomena Offers an in-depth exposition on renormalization and field theory techniques Includes experimental observations of critical effects Includes live examples

illustrating the applications of the theoretical material

First published in 1971, this highly popular text is devoted to the interdisciplinary area of critical phenomena, with an emphasis on liquid-gas and ferromagnetic transitions. Advanced undergraduate and graduate students in thermodynamics, statistical mechanics, and solid state physics, aswell as researchers in physics, mathematics, chemistry, and materials science, will welcome this paperback edition of Stanley's acclaimed text.

The Physics of Phase Transitions occupies an important place at the crossroads of several fields central to materials sciences. This second edition incorporates new developments in the states of matter physics, in particular in the domain of nanomaterials and atomic Bose-Einstein condensates where progress is accelerating. New information and application examples are included. This work deals with all classes of phase transitions in fluids and solids, containing chapters on evaporation, melting, solidification, magnetic transitions, critical phenomena, superconductivity, and more. End-of-chapter problems and complete answers are included.

Far-from-equilibrium phenomena, while abundant in nature, are not nearly as well understood as their equilibrium counterparts. On the theoretical side, progress is slowed by the lack of a simple framework, such as the Boltzmann-Gbbs paradigm in the case of equilibrium thermodynamics. On the experimental side, the enormous structural complexity of real systems poses serious obstacles to comprehension. Similar

difficulties have been overcome in equilibrium statistical mechanics by focusing on model systems. Even if they seem too simplistic for known physical systems, models give us considerable insight, provided they capture the essential physics. They serve as important theoretical testing grounds where the relationship between the generic physical behavior and the key ingredients of a successful theory can be identified and understood in detail. Within the vast realm of non-equilibrium physics, driven diffusive systems form a subset with particularly interesting properties. As a prototype model for these systems, the driven lattice gas was introduced roughly a decade ago. Since then, a number of surprising phenomena have been discovered including singular correlations at generic temperatures, as well as novel phase transitions, universality classes, and interfacial instabilities. This book summarizes current knowledge on driven systems, from apedagogical discussion of the original driven lattice gas to a brief survey of related models. Given that the topic is far from closed, much emphasis is placed on detailing open questions and unsolved problems as an incentive for the reader to pursue thesubject further. Provides a summary of current knowledge on driven diffusive systems Emphasis is placed on detailing open questions and unsolved problems Covers the entire subject from original driven lattice gas to a survey of related models

This book describes two main classes of non-equilibrium phase-transitions: static and dynamics of transitions into an absorbing state, and dynamical scaling in far-from-

equilibrium relaxation behavior and ageing.

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 and to partial differential equations add to the uniqueness of this book.

This work provides a systematic introduction to quantum field theory and renormalization group, as applied to particle physics and continuous macroscopic phase transitions.

Rigorous and comprehensive, this textbook introduces undergraduate students to simulation methods in statistical physics. The book covers a number of topics, including the thermodynamics of magnetic and electric systems; the quantum-mechanical basis of magnetism; ferrimagnetism, antiferromagnetism, spin waves and magnons; liquid crystals as a non-ideal system of technological relevance;

and diffusion in an external potential. It also covers hot topics such as cosmic microwave background, magnetic cooling and Bose-Einstein condensation. The book provides an elementary introduction to simulation methods through algorithms in pseudocode for random walks, the 2D Ising model, and a model liquid crystal. Any formalism is kept simple and derivations are worked out in detail to ensure the material is accessible to students from subjects other than physics.

No further information has been provided for this title.

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The field of phase transitions and critical phenomena continues to be active in research, producing a steady stream of interesting and fruitful results. It has moved into a central place in condensed matter studies. Statistical physics, and more specifically, the theory of transitions between states of matter, more or less defines what we know about 'everyday' matter and its transformations. The major aim of this serial is to provide review articles that can serve as standard references for research workers in the field, and for graduate students and others wishing to obtain reliable information on important recent developments.

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.

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