Introduction To Phase Transitions And Critical Phenomena International Series Of Monographs On Physics

A classical metastable state possesses a local free energy minimum at infinite sizes, but not a global one. This concept is phase size independent. We have studied a number of experimental results and proposed a new concept that there exists a wide range of metastable states in polymers on different length scales where their metastability is critically determined by the phase size and dimensionality. Metastable states are also observed in phase transformations that are kinetically impeded on the pathway to thermodynamic equilibrium. This was illustrated in structural and morphological investigations of crystallization and mesophase transitions, liquid-liquid phase separation, vitrification and gel formation, as well as combinations of these transformation processes. The phase behaviours in polymers are thus dominated by interlinks of metastable states on different length scales. This concept successfully explains many experimental observations and provides a new way to connect different aspects of polymer physics. * Written by a leading scholar and industry expert * Presents new and cutting edge material encouraging innovation and future research * Connects hot topics and leading research in one concise volume

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.

A clear, concise and rigorous textbook covering phase transitions in the context of advances in electronic structure and statistical mechanics.

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. -
Continuum Models for Phase Transitions and Twinning in Crystals presents the fundamentals of a remarkably successful approach to crystal thermomechanics. Developed over the last two decades, it is based on the mathematical theory of nonlinear thermoelasticity, in which a new viewpoint on material symmetry, motivated by molecular theories, plays a central role. This is the first organized presentation of a nonlinear elastic approach to twinning and displacive phase transition in crystalline solids. The authors develop geometry, kinematics, and energy invariance in crystals in strong connection and with the purpose of investigating the actual mechanical aspects of the phenomena, particularly in an elastostatics framework based on the minimization of a thermodynamic potential. Interesting for both mechanics and mathematical analysis, the new theory offers the possibility of investigating the formation of microstructures in materials undergoing martensitic phase transitions, such as shape-memory alloys. Although phenomena such as twinning and phase transitions were once thought to fall outside the range

of elastic models, research efforts in these areas have proved quite fruitful. Relevant to a variety of disciplines, including mathematical physics, continuum mechanics, and materials science, Continuum Models for Phase Transitions and Twinning in Crystals is your opportunity to explore these current research methods and topics.

This textbook describes the fundamental principles of structural phase transitions in materials in an easily understandable form, suitable for both undergraduate and graduate students.

The sophistication of modern tools used in the study of statistical mechanics and field theory is often an obstacle to the easy understanding of new important current results reported in journals. The main purpose of this book is to introduce the reader to the methods of the fluctuation (field) theory of phase transitions and critical phenomena so as to provide a good source for research. The introductory contents are concerned with ideas of description, thermodynamic stability theory related to phase transitions, major experimental facts, basic models and their relationships. Special attention is paid to the mean field approximation and to the Landau expansion for simple and complex models of critical and multicritical phenomena. An instructive representation of the modern perturbation theory and the method of the renormalization group is developed for field models of phase transitions. The essential influence of the fluctuations on the critical behaviour is established together with the theory of correlation functions, Gaussian approximation, the Ginzburg criterion, ?- and 1/n- expansions as practical realizations of the renormalization group ideas. Applications of the theory to concrete aspects of condensed matter physics are considered: quantum effects, Bose condensation, crystal anisotropy, superconductors and liquid crystals, effects of disorder of type randomly distributed quenched impurities and random fields. This volume can be used as an advanced University course book for students with a basic knowledge of statistical physics and quantum mechanics. It could be considered as a complementary text to a standard University course on statistical physics.

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.

The physics of phase transitions is an important area at the crossroads of several fields that play central roles in materials sciences. This work deals with broad classes of phase transitions in fluids and solids. It contains chapters on evaporation, melting, solidification, magnetic transitions, critical phenomena, superconductivity, etc., and is intended for graduate students in physics and engineering; for scientists it will serve both as an introduction and an overview. End-of-chapter problems and complete answers are included.

Describing the physical properties of quantum materials near critical points with long-range many-body quantum entanglement, this book introduces readers to the basic theory of quantum phases, their phase transitions and their observable properties. This second edition begins with a new section suitable for an introductory course on quantum phase transitions, assuming no prior knowledge of quantum field theory. It also contains several new chapters to cover important recent advances, such as the Fermi gas near unitarity, Dirac fermions, Fermi liquids and their phase transitions, quantum magnetism, and solvable models obtained from string theory. After introducing the basic theory, it moves on to a detailed description of the canonical quantum-critical phase diagram at non-zero temperatures. Finally, a variety of more complex models are explored. This book is ideal for graduate students and researchers in condensed matter physics and particle and string theory.

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.

Quantum phase transitions (QPTs) offer wonderful examples of the radical macroscopic effects inherent in quantum physics: phase changes between different forms of matter driven by quantum rather than thermal fluctuations, typically at very low temperatures. QPTs provide new insight into outstanding problems such as high-temperature superconductivit

Phase transitions--changes between different states of organization in a complex system--have long helped to explain physics concepts, such as why water freezes into a solid or boils to become a gas. How might phase transitions shed light on important problems in biological and ecological complex systems? Exploring the origins and implications of sudden changes in nature and society, Phase Transitions examines different dynamical behaviors in a broad range of complex systems. Using a compelling set of examples, from gene networks and ant colonies to human language and the degradation of diverse ecosystems, the book illustrates the power of simple models to reveal how phase transitions occur. Introductory chapters provide the critical concepts and the simplest mathematical techniques required to study phase transitions. In a series of example-driven chapters, Ricard Solé shows how such concepts and techniques can be applied to the analysis and prediction of complex system behavior, including the origins of life, viral replication, epidemics, language evolution, and the emergence and breakdown of societies. Written at an undergraduate mathematical level, this book provides the essential theoretical tools and foundations required to develop basic models to explain collective phase transitions for a wide variety of ecosystems.

Phase Transitions in Foods, Second Edition, assembles the most recent research and theories on the topic, describing the phase and state transitions that affect technological properties of biological materials occurring in food processing and storage. It covers the role of water as a plasticizer, the effect of transitions on mechanical and chemical changes, and the application of modeling in predicting stability rates of change. The volume presents methods for detecting changes in the physical state and various techniques used to analyze phase behavior of biopolymers and food components. It should become a valuable resource for anyone involved with food engineering, processing, storage, and quality, as well as those working on related properties of pharmaceuticals and other biopolymers. Contains descriptions of non-fat food solids as "biopolymers" which exhibit physical properties that are highly dependent on temperature, time, and water content Details the effects of water on the state and stability of foods Includes information on changes occurring in state and physicochemical properties during processing and storage The only book on phase and state transitions written specifically for the applications in food industry, product development, and research

About half a century ago Landau formulated the central principles of the phe nomenological second-order phase transition theory which is based on the idea of spontaneous symmetry breaking at phase transition. By means of this ap proach it has been possible to treat phase transitions of different nature in altogether distinct systems from a unified viewpoint, to embrace the aforemen tioned transitions by a unified body of mathematics and to show that, in a certain sense, physical systems in the vicinity of second-order phase transitions exhibit universal behavior. For several decades the Landau method has been extensively used to an alyze specific phase transitions in systems and has been providing a basis for interpreting experimental data on the behavior of physical characteristics near the phase transition, including the behavior of these characteristics in systems subject to various external effects such as pressure, electric and magnetic fields, deformation, etc. The symmetry aspects of Landau's theory are perhaps most effective in analyzing phase transitions in crystals because the relevant body of mathemat ics for this symmetry, namely, the crystal space group representation, has been worked out in great detail. Since particular phase transitions in crystals often call for a subtle symmetry analysis, the Landau method has been continually refined and developed over the past ten or fifteen years.

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A concise, comprehensive introduction to the topic of statistical physics of combinatorial optimization, bringing together theoretical concepts and algorithms from computer science with analytical methods from physics. The result bridges the gap between statistical physics and combinatorial optimization, investigating problems taken from theoretical computing, such as the vertex-cover problem, with the concepts and methods of theoretical physics. The authors cover rapid developments and analytical methods that are both extremely complex and spread by word-of-mouth, providing all the necessary basics in required detail. Throughout, the algorithms are shown with examples and calculations, while the proofs are given in a way suitable for graduate students, post-docs, and researchers. Ideal for newcomers to this young, multidisciplinary field.

Phase transitions in which crystalline solids undergo structural changes present an interesting problem in the interplay between the crystal structure and the ordering process. This text, intended for readers with some prior knowledge of condensed-matter physics, emphasizes the basic physics behind such spontaneous structural changes in crystals. Starting with the relevant thermodynamic principles, the book discusses the nature of order variables and their collective motion in a crystal lattice; in a structural phase transition a singularity in such a collective mode is responsible for the lattice instability, as revealed by soft phonons. This mechanism is analogous to the interplay of a charge-density wave and a periodically deformed lattice in low-dimensional conductors. The text also describes experimental methods for modulated crystal structures and gives examples of structural changes in representative systems.

The book is divided into two parts. The first, theoretical, part includes such topics as: the Landau theory of phase transitions; statistics, correlations and the mean-field approximation; pseudospins and their collective modes; soft lattice modes and pseudospin condensates; lattice imperfections and their role in the phase transitions of real crystals. The second part discusses experimental studies of modulated crystals using x-ray diffraction, neutron inelastic scattering, light scattering, dielectric measurements, and magnetic resonance spectroscopy.

Written by an experimentalist famous for his discovery of stishovite, with vast experience in phase transition studies, this book is devoted to a description of the continuous and discontinuous phase transitions. It includes chapters outlining the Van der Waals model, hard sphere and soft sphere models of melting, scaling phenomena, renormgroup approach to phase transitions, and experimental examples to illustrate various phase transitions.Unlike conventional books covering the same topic, this is meant for undergraduate students and experimentalists to understand basic concepts in the physics of phase transitions.

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

From a review of the first edition: "This book […] covers in depth a broad range of topics in the mathematical theory of phase transition in statistical mechanics. […] It is in fact one of the author's stated aims that this comprehensive monograph should serve both as an introductory text and as a reference for the expert." (F. Papangelou, Zentralblatt MATH) The second edition has been extended by a new section on large deviations and some comments on the more recent developments in the area.

Structural Phase Transitions II, like its predecessor (Topics in Current Physics, Vol. 23), presents selected methods and recent advances in the experimental investigation of phase transitions in solids. The two chapters in this volume deal with electron paramagnetic resonance (EPR), and with nuclear magnetic and nuclear quadrupole resonance (NMR-NQR). Both techniques are particularly sensitive to local properties. The chapter on EPR concentrates largely on the investigation of static properties, including mean-field behaviour, critical and multicritical phenomena, whilst NMR is shown to be a powerful tool for studying nonlinear dynamics, incommensurate transitions, and disordered systems. This book will serve as an excellent introduction to the methodology and applications of EPR and NMR-NQR for all those wishing to become acquainted with these important tools for studying structural phase transitions. 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.

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.

No further information has been provided for this title.

Providing a comprehensive introduction with the necessary background material to make it accessible for a wide scientific audience, Kinetics of Phase Transitions discusses developments in domain-growth kinetics. This book combines pedagogical chapters from leading experts in this area and focuses on incorporating various experimentally relevant effects—such as disorder, strain fields, and wetting surfaces—into studies of phase ordering dynamics. In addition, it highlights topics garnering recent interest, such as the growth of nanostructures on surfaces. This book also provides a comprehensive overview of numerical techniques, which have proven useful in studying these complex nonlinear problems.

The Nato Advanced Study Institute "Phase Transitions in Liquid Crystals" was held May 2-12, 1991, in Erice, Sicily. This was the 16th conference organized by the International School of Quantum Electronics, under the auspices of the "Ettore Majorana" Centre for Scientific Culture. The subject of "Liquid Crystals" has made amazing progress since the last ISQE Course on this subject in 1985. The present Proceedings give a tutorial introduction to today's most important areas, as well as a review of current results by leading researchers. We have brought together some of the world's acknowledged experts in the field to summarize both the present state of their research and its background. Most of the lecturers attended all the lectures and devoted their spare hours to stimulating discussions. We would like to thank them all for their admirable contributions. The Institute also took advantage of a very active audience; most of the students were active researchers in the field and contributed with discussions and seminars. Some of these student seminars are also included in these Proceedings. We did not modify the original manuscripts in editing this book, but we did group them according to the following topics: 1) "Theoretical Foundations"; 2) "Thermotropic Liquid Crystals"; 3) "Ferroelectric Liquid Crystals"; 4) "Polymeric Liquid Crystals"; and 5) "Lyotropic Liquid Crystals".

Filling a gap in the literature, this crucial publication on the renowned Lifshitz-Slezov-Wagner Theory of first-order phase transitions is authored by one of the scientists who gave it its name. Prof Slezov spent decades analyzing this topic and obtained a number of results that form the cornerstone of this rapidly developing branch of science. Following an analysis of unresolved problems together with proposed solutions, the book develops a theoretical description of the overall course of first-order phase transformations, starting from the nucleation state right up to the late stages of coarsening. In so doing, the author illustrates the results by way of numerical computations and experimental applications. The outline of the general results is performed for segregation processes in solutions and the results used in the analysis of a variety of different topics, such as phase formation in multi-component solutions, boiling in one- and multi-component liquids, vacancy cluster evolution in solids with and without influence of radiation, as well as phase separation in helium at low temperatures. The result is a detailed overview of the theoretical description of the whole course of nucleation-growth processes and applications for a wide audience of scientists and students.

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.

The publication of this second edition was motivated by several facts. First of all, the first edition had been sold out in less than one year. It had found excellent critics and enthusiastic responses from professors and students welcoming this new interdisciplinary approach. This appreciation is reflected by the fact that the book is presently translated into Russian and Japanese also. I have used this opportunity to include some of the most interesting recent developments. Therefore I have added a whole new chapter on the fascinating and rapidly growing field of chaos dealing with irregular motion caused by deterministic forces. This kind of phenomenon is presently found in quite diverse fields ranging from physics to biology. Furthermore I have included a section on the analytical treatment of a morphogenetic model using the order parameter concept developed in this book. Among the further additions, there is now a complete description of the onset of ultrashort laser pulses. It goes without· saying that the few minor mis prints or errors of the first edition have been corrected. I wish to thank all who have helped me to incorporate these additions.

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.

This book deals with the phenomenological theory of first-order structural phase transitions, with a special emphasis on reconstructive transformations in which a group-subgroup relationship between the symmetries of the phases is absent. It starts with a unified presentation of the current approach to first-order phase transitions, using the more recent results of the Landau theory of phase transitions and of the theory of singularities. A general theory of reconstructive phase transitions is then formulated, in which the structures surrounding a transition are expressed in terms of density-waves, providing a natural definition of the transition order-parameters, and a description of the corresponding phase diagrams and relevant physical properties. The applicability of the theory is illustrated by a large number of concrete examples pertaining to the various classes of reconstructive transitions: allotropic transformations of the elements, displacive and order-disorder transformations in metals, alloys and related structures, crystal-quasicrystal transformations.

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.

This textbook gradually introduces students to the statistical mechanical study of the different phases of matter and to the phase transitions between them. It uses simple yet fully detailed models of both hard and soft matter systems to demonstrate core concepts, developing the subject matter in a thorough and accessible pedagogical manner throughout. Starting from an introduction to basic thermodynamics and statistical physics, the book progresses from ideal, non-interacting systems to real systems exhibiting classical interactions and phase transitions. It concludes with a selection of more advanced topics, such as the renormalisation group approach to critical phenomena, the density functional theory of interfaces, and kinematic aspects of the phase transformation process. This updated second edition features a considerably expanded study of the topology of the phases, including applications to modern problems such as topological defects of nematic liquid crystals and the topological phase transition of a two-dimensional spin system. Along with a complete introductory overview of the theory of phase transitions, this textbook provides students with ample material for deeper study. References include suggestions for more detailed treatments and six appendices supply overviews of the mathematical tools employed in the text.

This book introduces new concepts in the phenomenon of 1st order phase transitions. It discusses the concept of kinetic arrest at a certain temperature, with this temperature being dependent on the second control variable (magnetic field, or pressure). It discusses interesting manifestations of this phenomenon when the 1st order transition is broadened, i.e. occurs over a finite range of temperatures. Many examples of this phenomenon, observed recently in many materials, will also be discussed.

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.

The use of high-pressure techniques has become popular for studying the nature of substances and phenomena occurring in them, especially as a means of obtaining new materials (synthesis under high pressure) and processing known materials (hydroextrusion). A product of many years of research by the authors and their colleagues, Phase Transitions in Solids under High Pressure discusses the relationships of phase transformations in solids under high pressure, the mechanism of these transformations, crystal geometry, the effect of deformation, the conditions of formation, and preservation of the high-pressure phases under normal pressure. The book begins with an introduction that describes the relationship of the thermodynamics of phase transformations and the kinetics of the transformations. This is followed by a chapter explaining the equipment and mostly original procedures for investigating phase transformation in solids under high hydrostatic and quasi-hydrostatic pressures. The book covers phase transformations under high pressure in a wide temperature range in the elements carbon, silicon, germanium, titanium, zirconium, iron, gallium, and cerium as well as in titanium- and iron-based alloys and AIBVII, AIIBVI, and AIIIBV compounds. In addition, the book examines the kinetics of phase transformations in iron-based alloys in isobaric–isothermal conditions. The authors present results for phase transformations in deformation under high pressure, describe several non-trivial effects associated with phase transformations under high pressure, and analyze the kinetics and hysteresis of high-temperature and low-temperature phase transformations. They conclude by describing the role of investigations under high pressure for determining general relationships governing phase transformations in solids.

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.