Lectures On Phase Transitions And The Renormalization Group Frontiers In Physics

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String Theory and Its Applications Cambridge University Press
Twenty Lectures on Thermodynamics is a course of lectures, parts of which the author has given various times over the last few years. The book gives the readers a bird's eye view of phenomenological and statistical thermodynamics. The book covers many areas in thermodynamics such as states and transition; adiabatic isolation; irreversibility; the first, second, third and Zeroth laws of thermodynamics; entropy and entropy law; the idea of the application of thermodynamics; pseudo-states; the quantum-static al canonical and grand canonical ensembles; and semi-classical gaseous systems. The text is recommended for physics students who are in need of a basic yet effective knowledge in the foundations of thermodynamics, as the book explains its many concepts in such an elementary and pedagogic manner, giving the readers a greater understanding of the core of the subject.
What You Need to Know to Start Doing Physics World Scientific
This textbook concentrates on modern topics in statistical physics with an emphasis on strongly interacting condensed matter systems. The book is self-contained and is suitable for beginning graduate students in physics and materials science or undergraduates who have taken an introductory course in statistical mechanics. Phase transitions and critical phenomena are discussed in detail including mean field and Landau theories and the renormalization group approach. The theories are applied to a number of interesting systems such as magnets, liquid crystals, polymers, membranes, interacting Bose and Fermi fluids; disordered systems, percolation and spin of equilibrium concepts are also discussed. Computer simulations of condensed matter systems by Monte Carlo-based and molecular dynamics methods are treated.
Introduction to Statistical Physics CRC Press
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, 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.
World Scientific
The renormalization-group approach is largely responsible for the considerable success which has been achieved in the last ten years in developing a complete quantitative theory of phase transitions. Before, there was a useful physical picture of phase transitions, but a general method for making accurate quantitative predictions was lacking. Existent theories, such as the mean-field theory of Landau, sometimes reproduce phase diagrams reliably but were known to fail qualitatively near critical points, where the critical behavior is particularly interesting be cause of its universal character. In the mid 1960's Widom found that the singularities in thermodynamic quanti ties were well described by homogeneous functions. Kadanoff extended the homogeneity hypothesis to correlation functions and linked it to the idea of scale invariance. In the early 1970's Wilson showed how Kadanoff's rescaling could be explicitly carried out near the fixed point of a flow in Hamiltonian space. He made the first practical renormalization-group calculation of the flow induced by the elimination of short-wave-length Fourier components of the order-parameter field. The univer sality of the critical behavior emerges in a natural way in this approach, with a different fixed point for each universality class. The discovery by Wilson and Fisher of a systematic expansion procedure in E for a system in d = 4 - E dimen sions was followed by a cascade of calculations of critical quantities as a function of d and of the order-parameter dimensionality n.
Order, Disorder and Criticality CRC Press
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. -

Twenty Lectures on Thermodynamics Springer Science & Business Media

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

Lectures on Statistical Physics and Protein Folding World Scientific

Modern introduction to quantum field theory for graduates, providing intuitive, physical explanations supported by real-world applications and homework problems.

Statistical Physics of Fields Cambridge University Press

Systems with competing energy scales are widespread and exhibit rich and subtle behaviour, although their systematic study is a relatively recent activity. This text presents lectures given at a NATO Advanced Study Institute reviewing the current knowledge and understanding of this fascinating subject, particularly with regard to phase transitions and dynamics, at an advanced tutorial level. Both general and specific aspects are considered, with competitions having several origins; differences in intrinsic interactions, interplay between intrinsic and extrinsic effects, such as geometry and disorder; irreversibility and non-equilibration. Among the specific physical application areas are supercooled liquids and glasses, high-temperature superconductors, flux or vortex pinning and motion, charge density waves, domain growth and coarsening, and electron solidification.

Real-Space Renormalization Cambridge University Press

1) Phase Transitions, represented by generalizations of the classical Stefan problem. This is studied by Kenmochi and Rodrigues by means of variational techniques. 2) Hysteresis Phenomena. Some alloys exhibit shape memory effects, corresponding to a stress-strain relation which strongly depends on temperature; mathematical physical aspects are treated in Müller's paper. In a general framework, hysteresis can be described by means of hysteresis operators in Banach spaces of time dependent functions; their properties are studied by Brokate. 3) Numerical analysis. Several models of the phenomena above can be formulated in terms of nonlinear parabolic equations. Here Verdi deals with the most updated approximation techniques.

Quantum Scaling in Many-Body Systems Basic Books

The material presented in this invaluable textbook has been tested in two courses. One of these is a graduate-level survey of statistical physics; the other, a rather personal perspective on critical behavior. Thus, this book defines a progression starting at the book-learning part of graduate education and ending in the midst of topics at the research level. To supplement the research-level side the book includes some research papers. Several of these are classics in the field, including a suite of six works on self-organized criticality and complexity, a pair on diffusion-limited aggregation, some papers on correlations near critical points, a few of the basic sources on the development of the real-space renormalization group, and several papers on magnetic behavior in a plain geometry. In addition, the author has included a few of his own papers.

TASI 2010, from MeV to the Planck Scale : Proceedings of the 2010 Theoretical Advanced Study Institute in Elementary Particle Physics Springer

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

World Scientific

The renormalization group (RG) has nowadays achieved the status of a meta-theory, which is a theory about theories. The theory of the RG consists of a set of concepts and methods which can be used to understand phenomena in many different ?elds of physics, ranging from quantum ?eld theory over classical statistical mechanics to nonequilibrium phenomena. RG methods are particularly useful to understand phenomena where ?uctuations involving many different length or time scales lead to the emergence of new collective behavior in complex many-body systems. In view of the diversity of ?elds where RG methods have been successfully applied, it is not surprising that a variety of apparently different implementations of the RG idea have been proposed. Unfortunately, this makes it somewhat dif?cult for beginners to learn this technique. For example, the ?eld-theoretical formulation of the RG idea looks at the ?rst sight rather different from the RG approach pioneered by Wilson, the latter being based on the concept of the effective action which is ite- tively calculated by successive elimination of the high-energy degrees of freedom. Moreover, the Wilsonian RG idea has been implemented in many different ways, depending on the particular problem at hand, and there seems to be no canonical way of setting up the RG procedure for a given problem.

Finite-Size Scaling Cambridge University Press

A Wall Street Journal Best Book of 2013 If you ever regretted not taking physics in college--or simply want to know how to think like a physicist--this is the book for you. In this bestselling introduction, physicist Leonard Susskind and hacker-scientist George Hrabovsky offer a first course in physics and associated math for the ardent amateur. Challenging, lucid, and concise, The Theoretical Minimum provides a tool kit for amateur scientists to learn physics at their own pace.

Lectures On Phase Transitions And The Renormalization Group The Mineralogical Society of Great Britain and Ireland

Topological defects formed at symmetry-breaking phase transitions play an important role in many different fields of physics. They appear in many condensed-matter systems at low temperature; examples include vortices in superfluid helium-4, a rich variety of defects in helium-3, quantized mag netic flux tubes in type-II superconductors, and disclination lines and other defects in liquid crystals. In cosmology, unified gauge theories of particle interactions suggest a sequence of phase transitions in the very early uni verse some of which may lead to defect formation. In astrophysics, defects play an important role in the dynamics of neutron stars. In 1997 the European Science Foundation started the scientific network "Topological defects" headed by Tom Kibble. This network has provided us with a unique opportunity of establishing a collaboration between the representatives of these very different branches of modern physics. The NATO-ASI (Advanced Study Institute), held in Les Houches in February 1999 thanks to the support of the Scientific Division of NATO, the European Science Foundation and the CNRS, represents a key event of this ESF network. It brought together participants from widely different fields, with diverse expertise and vocabulary, fostering the exchange of ideas. The lectures given by particle physicists, cosmologists and condensed matter physicists are the result of the fruitful collaborations established since 1997 between groups in several European countries and in the U.S.A.

Principles of Condensed Matter Physics Cambridge University Press
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.

Microcanonical Thermodynamics Clarendon Press
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.

Kinetics of Phase Transitions Springer Science & Business Media
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.

From Phase Transitions to Turbulence CRC Press
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 World Scientific
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.

Statistical Physics Oxford University Press
Now in paperback, this book provides an overview of the physics of condensed matter systems. Assuming a familiarity with the basics of quantum mechanics and statistical mechanics, the book establishes a general framework for describing condensed phases of matter, based on symmetries and conservation laws. It explores the role of spatial dimensionality and microscopic interactions in determining the nature of phase transitions, as well as discussing the structure and properties of materials with different symmetries. Particular attention is given to critical phenomena and renormalization group methods. The properties of liquids, liquid crystals, quasicrystals, crystalline solids, magnetically ordered systems and amorphous solids are investigated in terms of their symmetry, generalised rigidity, hydrodynamics and topological defect structure. In addition to serving as a course text, this book is an essential

reference for students and researchers in physics, applied physics, chemistry, materials science and engineering, who are interested in modern condensed matter physics.