Application Of The Statistical Physics Methods For The

This popular, often cited text returns in a softcover edition to provide a thorough introduction to statistical physics and thermodynamics, and to exhibit the universal chain of ideas leading from the laws of microphysics to the macroscopic behaviour of matter. A wide range of applications illustrates the concepts, and many exercises reinforce understanding. Volume II applies statistical methods to systems governed by quantum effects, in particular to solid state physics, explaining properties due to the crystal structure or to the lattice excitations or to the electrons. The last chapters are devoted to non-equilibrium processes and to kinetic equations, with many applications included.

The aim of this book is to provide the fundamentals of statistical physics and its application to condensed matter. The combination of statistical mechanics and quantum mechanics has provided an understanding of properties of matter leading to spectacular technological innovations and discoveries in condensed matter which have radically changed our daily life. The book gives the steps to follow to understand fundamental theories and to apply these to real materials.

A thorough and pedagogical introduction to phase transitions and exactly solved models in statistical physics and quantum field theory.

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.

This text presents the mathematical concepts of Grassmann variables and the method of supersymmetry to a broad audience of physicists interested in applying these tools to disordered and critical systems, as well as related topics in statistical physics. Based on many courses and seminars held by the author, one of the pioneers in this field, the reader is given a systematic and tutorial introduction to the subject matter. The algebra and analysis of Grassmann variables is presented in part I. The mathematics of these variables is applied to a random matrix model, path integrals for fermions, dimer models and the Ising model in two dimensions. Supermathematics - the use of commuting and anticommuting variables on an equal footing - is the subject of part II. The properties of supervectors and supermatrices, which contain both commuting and Grassmann components, are treated in great detail, including the derivation of integral theorems. In part III, supersymmetric physical models are considered. While supersymmetry was first introduced in elementary particle physics as exact symmetry between bosons and fermions, the formal introduction of anticommuting spacetime components, can be extended to problems of statistical physics, and, since it connects states with equal energies, has also found its way into quantum mechanics. Several models are considered in the applications, after which the representation of the random matrix model by the nonlinear sigma-model, the determination of the density of states and the level correlation are derived. Eventually, the mobility edge behavior is discussed and a short account of the ten symmetry classes of disorder, two-dimensional disordered models, and superbosonization is given.

This innovative and modular textbook combines classical topics in thermodynamics, statistical mechanics and many-body theory with the latest developments in condensed matter physics research. Written by internationally renowned experts and logically structured to cater for undergraduate and postgraduate students and researchers, it covers the underlying theoretical principles and includes numerous problems and worked examples to put this knowledge into practice. Three main streams provide a framework for the book; beginning with thermodynamics and classical statistical mechanics, including mean field approximation, fluctuations and the renormalization group approach to critical phenomena. The authors then examine quantum statistical mechanics, covering key topics such as normal Fermi and Luttinger liquids, superfluidity and superconductivity. Finally, they explore classical and quantum kinetics, Anderson localization and quantum interference, and disordered Fermi liquids. Unique in providing a bridge between thermodynamics and advanced topics in condensed matter, this textbook is an invaluable resource to all students of physics.

This book is based on many years of teaching statistical and thermal physics. It assumes no previous knowledge of thermodynamics, kinetic theory, or probability---the only prerequisites are an elementary knowledge of classical and modern physics, and of multivariable calculus. The first half of the book introduces the subject inductively but rigorously, proceeding from the concrete and specific to the abstract and general. In clear physical language the book explains the key concepts, such as temperature, heat, entropy, free energy, chemical potential, and distributions, both classical and quantum. The second half of the book applies these concepts to a wide variety of phenomena, including perfect gases, heat engines, and transport processes. Each chapter contains fully worked examples and real-world problems drawn from physics, astronomy, biology, chemistry, electronics, and mechanical engineering.

This systematic book covers in simple language the physical foundations of evolution equations, stochastic processes and generalized Master equations applied on complex economic systems, helping to understand the large variability of financial markets, trading and communications networks.

Bridging the gap between traditional books on quantum and statistical physics, this series is an ideal introductory course for students who are looking for an alternative approach to the traditional academic treatment.This pedagogical approach relies heavily on scientific or technological applications from a wide range of fields. For every new concept introduced, an application is given to connect the theoretical results to a real-life situation. Each volume features in-text exercises and detailed solutions, with easy-to-understand applications.Building on the principles introduced in Volume 1, this second volume explains the structure of atoms, the vibration and rotation of molecules. It describes how this is related to thermodynamics through statistical physics. It is shown that these fundamental achievements help to understand how explosives and CO? can be detected, what makes a gecko stick to the ceiling, why old stars do not necessarily collapse, where nuclear energy comes from, and more.

Statistical physics is a core component of most undergraduate (and some post-graduate) physics degree courses. It is primarily concerned with the behavior of matter in bulk-from boiling water to the superconductivity of metals. Ultimately, it seeks to uncover the laws governing random processes, such as the snow on your TV screen. This essential new textbook guides the reader quickly and critically through a statistical view of the physical world, including a wide range of physical applications to illustrate the methodology. It moves from basic examples to more advanced topics, such as broken symmetry and the Bose-Einstein equation. To accompany the text, the author, a renowned expert in the field, has written a Solutions Manual/Instructor's Guide, available free of charge to lecturers who adopt this book for their courses. Introduction to Statistical Physics will appeal to students and researchers in physics, applied mathematics and statistics.

The field of statistical physics has undergone a spectacular development in recent years. The fundamentals of the subject have advanced dynamically with multidisciplinary approaches involving physicists, chemists and mathematicians. Equally spectacular has been the development of applications of statistical mechanics to shed light on a wide range of problems, many of them arising in fields quite distant from traditional physics disciplines. Recent applications range from such topics as oil recovery from porous rock to protein folding, DNA structure, morphogenesis and the cooperative behavior of living creatures. Concepts and methods of statistical physics have been applied successfully to "exotic" problems that seem to be far from physics, such as vehicular and pedestrial traffic, or economy and finance. This book presents not only the keynote invited talks, but a number of high quality, interesting, contributed communications from senior scientists and young students active in the field. Topics covered include DNA migration, wetting, chemical waves, granular media, molecular motors, biological pattern formation and motion, as well as practical problems such as heart diagnosis, internet traffic jamming, oil recovery and econophysics.

Deals with the computer simulation of complex physical sys- tems encounteredin condensed-matter physics and statistical mechanics as well as in related fields such as metallurgy, polymer research, lattice gauge theory and quantummechanics.

This book provides a comprehensive exposition of the theory of equilibrium thermodynamics and statistical mechanics at a level suitable for well-prepared undergraduate students. The fundamental message of the book is that all results in equilibrium thermodynamics and statistical mechanics follow from a single unprovable axiom — namely, the principle of equal a priori probabilities — combined with elementary probability theory, elementary classical mechanics, and elementary quantum mechanics.

Statistical Physics offers an advanced treatment with numerous applications to modern problems of relevance to researchers and students. Supplementing the concepts and methods employed in statistical mechanics, the book also covers the fundamentals of probability and statistics, mathematical statistics, and stochastic methods for the analysis of data. It is divided into two parts, the first focusing on the modeling of statistical systems, the second on the analysis of these systems.

This book provides a comprehensive presentation of the basics of statistical physics. The first part explains the essence of statistical physics and how it provides a bridge between microscopic and macroscopic phenomena, allowing one to derive quantities such as entropy. Here the author avoids going into details such as Liouville’s theorem or the ergodic theorem, which are difficult for beginners and unnecessary for the actual application of the statistical mechanics. In the second part, statistical mechanics is applied to various systems which, although they look different, share the same mathematical structure. In this way readers can deepen their understanding of statistical physics. The book also features applications to quantum dynamics, thermodynamics, the Ising model and the statistical dynamics of free spins.

This textbook is the result of the enhancement of several courses on non-equilibrium statistics, stochastic processes, stochastic differential equations, anomalous diffusion and disorder. The target audience includes students of physics, mathematics, biology, chemistry, and engineering at undergraduate and graduate level with a grasp of the basic elements of mathematics and physics of the fourth year of a typical undergraduate course. The little-known physical and mathematical concepts are described in sections and specific exercises throughout the text, as well as in appendices. Physical-mathematical motivation is the main driving force for the development of this text. It presents the academic topics of probability theory and stochastic processes as well as new educational aspects in the presentation of non-equilibrium statistical theory and stochastic differential equations.. In particular it discusses the problem of irreversibility in that context and the dynamics of Fokker-Planck. An introduction on fluctuations around metastable and unstable points are given. It also describes relaxation theory of non-stationary Markov periodic in time systems. The theory of finite and infinite transport in disordered networks, with a discussion of the issue of anomalous diffusion is introduced. Further, it provides the basis for establishing the relationship between quantum aspects of the theory of linear response and the calculation of diffusion coefficients in amorphous systems.

Statistical mechanics has been proven to be successful at describing physical systems at thermodynamic equilibrium. Since most natural phenomena occur in nonequilibrium conditions, the present challenge is to find suitable physical approaches for such conditions: this book provides a pedagogical pathway that explores various perspectives. The use of clear language, and explanatory figures and diagrams to describe models, simulations and experimental findings makes the book a valuable resource for undergraduate and graduate students, and also for lecturers organizing teaching at varying levels of experience in the field. Written in three parts, it covers basic and traditional concepts of nonequilibrium physics, modern aspects concerning nonequilibrium phase transitions, and application-orientated topics from a modern perspective. A broad range of topics is covered, including Langevin equations, Levy processes, directed percolation, kinetic roughening and pattern formation.

Suitable for graduate students in chemical physics, statistical physics, and physical chemistry, this text develops an innovative, probabilistic approach to statistical mechanics. The treatment employs Gauss's principle and incorporates Bose-Einstein and Fermi-Dirac statistics to provide a powerful tool for the statistical analysis of physical phenomena. The treatment begins with an introductory chapter on entropy and probability that covers Boltzmann's principle and thermodynamic probability, among other topics. Succeeding chapters offer a case history of black radiation, examine quantum and classical statistics, and discuss methods of processing information and the origins of the canonical distribution. The text concludes with explorations of statistical equivalence, radiative and material phase transitions, and the kinetic foundations of Gauss's error law. Bibliographic notes complete each chapter.

'Several features make this book unusual. The first is the historical content … Second, the practical importance of quantum physics is demonstrated by the inclusion of numerous summary discussions of technological applications … A third unusual feature of this book is a detailed solution immediately following each in-text exercise. Each such problem is used to advance the discussion, and the question-and-answer format encourages the student to wrestle with the ideas personally rather than simply reading passively … This short book would easily make a helpful secondary text allowing an instructor to touch on some non-traditional topics such as least action principles and path integrals.'Contemporary PhysicsBridging the gap between traditional books on quantum and statistical physics, this series is an ideal introductory course for students who are looking for an alternative approach to the traditional academic treatment.This pedagogical approach relies heavily on scientific or technological applications from a wide range of fields. For every new concept introduced, an application is given to connect the theoretical results to a real-life situation. Each volume features in-text exercises and detailed solutions, with easy-to-understand applications.This first volume sets the scene of a new physics. It explains where quantum mechanics come from, its connection to classical physics and why it was needed at the beginning of the twentieth century. It examines how very simple models can explain a variety of applications such as quantum wells, thermoluminescence dating, scanning tunnel microscopes, quantum cryptography, masers, and how fluorescence can unveil the past of art pieces.

Applications of Statistical PhysicsProceedings of the NATO Advanced Research Workshop Held at Technical University of Budapest, Hungary, 19-22 May 1999North-Holland

Classic text combines thermodynamics, statistical mechanics, and kinetic theory in one unified presentation. Topics include equilibrium statistics of special systems, kinetic theory, transport coefficients, and fluctuations. Problems with solutions. 1966 edition.

A careful examination of the interaction between physics and finance. It takes a look at the 100-year-long history of co-operation between the two fields and goes on to provide new research results on capital markets - taken from the field of statistical physics. The random walk model, well known in physics, is one good example of where the two disciplines meet. In the world of finance it is the basic model upon which the Black-Scholes theory of option pricing and hedging has been built. The underlying assumptions are discussed using empirical financial data and analogies to physical models such as fluid flows, turbulence, or superdiffusion. On this basis, new theories of derivative pricing and risk control can be formulated.

A self-contained, mathematical introduction to the driving ideas in equilibrium statistical mechanics, studying important models in detail.

The focus is on the main physical ideas and mathematical methods of the microscopic theory of fluids, starting with the basic principles of statistical mechanics. The detailed derivation of results is accompanied by explanation of their physical meaning. The same approach refers to several specialized topics of the liquid state, most of which are recent developments, such as: a perturbation approach to the surface tension, an algebraic perturbation theory of polar nonpolarizable fluids and ferrocolloids, a semi-phenomenological theory of the Tolman length and some others.

This is the definitive treatise on the fundamentals of statistical mechanics. A concise exposition of classical statistical mechanics is followed by a thorough elucidation of quantum statistical mechanics: postulates, theorems, statistical ensembles, changes in quantum mechanical systems with time, and more. The final two chapters discuss applications of statistical mechanics to thermodynamic behavior. 1930 edition.

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 book formulates a unified approach to the description of many-particle systems combining the methods of statistical physics and quantum field theory. The benefits of such an approach are in the description of phase transitions during the formation of new spatially inhomogeneous phases, as well in describing quasi-equilibrium systems with spatially inhomogeneous particle distributions (for example, self-gravitating systems) and metastable states.The validity of the methods used in the statistical description of many-particle systems and models (theory of phase transitions included) is discussed and compared. The idea of using the quantum field theory approach and related topics (path integration, saddle-point and stationary-phase methods, Hubbard-Stratonovich transformation, mean-field theory, and functional integrals) is described in detail to facilitate further understanding and explore more applications.To some extent, the book could be treated as a brief encyclopedia of methods applicable to the statistical description of spatially inhomogeneous equilibrium and metastable particle distributions. Additionally, the general approach is not only formulated, but also applied to solve various practically important problems (gravitating gas, Coulomb-like systems, dusty plasmas, thermodynamics of cellular structures, non-uniform dynamics of gravitating systems, etc.).

Methods of Statistical Physics is an exposition of the tools of statistical mechanics, which evaluates the kinetic equations of classical and quantized systems. The book also analyzes the equations of macroscopic physics, such as the equations of hydrodynamics for normal and superfluid liquids and macroscopic electrodynamics. The text gives particular attention to the study of quantum systems. This study begins with a discussion of problems of quantum statistics with a detailed description of the basics of quantum mechanics along with the theory of measurement. An analysis of the asymptotic behavior of universal quantities is also explained. Strong consideration is given to the systems with spontaneously broken system. Theories such as the kinetic theory of gases, the theory of Brownian motion, the theory of the slowing down of neutrons, and the theory of transport phenomena in crystals are discussed. The book will be a useful tool for physicists, mathematicians, students, and researchers in the field of statistical mechanics.

The Manchester Physics Series General Editors: D. J. Sandiford; F. Mandl; A. C. Phillips Department of Physics and Astronomy, University of Manchester Properties of Matter B. H. Flowers and E. Mendoza Optics Second Edition F. G. Smith and J. H. Thomson Statistical Physics Second Edition E. Mandl Electromagnetism Second Edition I. S. Grant and W. R. Phillips Statistics R. J. Barlow Solid State Physics Second Edition J. R. Hook and H. E. Hall Quantum Mechanics F. Mandl Particle Physics Second Edition B. R. Martin and G. Shaw The Physics of Stars Second Edition A. C. Phillips Computing for Scientists R. J. Barlow and A. R. Barnett Statistical Physics, Second Edition develops a unified treatment of statistical mechanics and thermodynamics, which emphasises the statistical nature of the laws of thermodynamics and the atomic nature of matter. Prominence is given to the Gibbs distribution, leading to a simple treatment of quantum statistics and of chemical reactions. Undergraduate students of physics and related sciences will find this a stimulating account of the basic physics and its applications. Only an elementary knowledge of kinetic theory and atomic physics, as well as the rudiments of quantum theory, are presupposed for an understanding of this book. Statistical Physics, Second Edition features: A fully integrated treatment of thermodynamics and statistical mechanics. A flow diagram allowing topics to be studied in different orders or omitted altogether. Optional "starred" and highlighted sections containing more advanced and specialised material for the more ambitious reader. Sets of problems at the end of each chapter to help student understanding. Hints for solving the problems are given in an Appendix.

A completely revised edition that combines a comprehensive coverage of statistical and thermal physics with enhanced computational tools, accessibility, and active learning activities to meet the needs of today's students and educators This revised and expanded edition of Statistical and Thermal Physics introduces students to the essential ideas and techniques used in many areas of contemporary physics. Ready-to-run programs help make the many abstract concepts concrete. The text requires only a background in introductory mechanics and some basic ideas of quantum theory, discussing material typically found in undergraduate texts as well as topics such as fluids, critical phenomena, and computational techniques, which serve as a natural bridge to graduate study. Completely revised to be more accessible to students Encourages active reading with guided problems tied to the text Updated open source programs available in Java, Python, and JavaScript Integrates Monte Carlo and molecular dynamics simulations and other numerical techniques Self-contained introductions to thermodynamics and probability, including Bayes' theorem A fuller discussion of magnetism and the Ising model than other undergraduate texts Treats ideal classical and quantum gases within a uniform framework Features a new chapter on transport coefficients and linear response theory Draws on findings from contemporary research Solutions manual (available only to instructors)

Bridging the gap between traditional books on quantum and statistical physics, this series is an ideal introductory course for students who are looking for an alternative approach to the traditional academic treatment.This pedagogical approach relies heavily on scientific or technological applications from a wide range of fields. For every new concept introduced, an application is given to connect the theoretical results to a real-life situation. Each volume features in-text exercises and detailed solutions, with easy-to-understand applications.This third volume covers several basic and more advanced subjects about transitions in quantum and statistical physics. Part I describes how the quantum statistics of fermions and bosons differ and under what condition they can merge into the classical-particle-statistics framework seen in Volume 2. This section also describes the fundamentals of conductors, semiconductors, superconductors, superfluids and Bose-Einstein condensates. Part II introduces time-dependent transitions between quantum states. The time evolution of a simple two-level model gives the minimum background necessary to understand the principles behind lasers and their numerous applications. Time-dependent perturbation theory is also covered, as well as standard approaches to the scattering of massive particles. A semi-classical treatment of electromagnetic field-matter interaction is described with illustrations taken from a variety of processes such as phonon scattering, charge distribution or spin densities. The third and last part of the book gives a brief overview of quantum electrodynamics with applications to photon absorption or emission spectroscopies and a range of scattering regimes. There follows a short introduction to the role of multiphoton processes in quantum entanglement based experiments.

Key features include an elementary introduction to probability, distribution functions, and uncertainty; a review of the concept and significance of energy; and various models of physical systems. 1968 edition.

The application of statistical methods to physics is essential. This unique book on statistical physics offers an advanced approach with numerous applications to the modern problems students are confronted with. Therefore the text contains more concepts and methods in statistics than the student would need for statistical mechanics alone. Methods from mathematical statistics and stochastics for the analysis of data are discussed as well. The book is divided into two parts, focusing first on the modeling of statistical systems and then on the analysis of these systems. Problems with hints for solution help the students to deepen their knowledge. The third edition has been updated and enlarged with new sections deepening the knowledge about data analysis. Moreover, a customized set of problems with solutions is accessible on the Web at extras.springer.com.

Standard text opens with clear, concise chapters on classical statistical mechanics, quantum statistical mechanics, and the relation of statistical mechanics to thermodynamics. Further topics cover fluctuations, the theory of imperfect gases and condensation, distribution functions and the liquid state, nearest neighbor (Ising) lattice statistics, and more.

Statistical Physics bridges the properties of a macroscopic system and the microscopic behavior of its constituting particles, otherwise impossible due to the giant magnitude of Avogadro's number. Numerous systems of today's key technologies - such as semiconductors or lasers - are macroscopic quantum objects; only statistical physics allows for understanding their fundamentals. Therefore, this graduate text also focuses on particular applications such as the properties of electrons in solids with applications, and radiation thermodynamics and the greenhouse effect.

The application of statistical methods to physics is essential. This unique book on statistical physics offers an advanced approach with numerous applications to the modern problems students are confronted with. Therefore the text contains more concepts and methods in statistics than the student would need for statistical mechanics alone. Methods from mathematical statistics and stochastics for the analysis of data are discussed as well. The book is divided into two parts, focusing first on the modeling of statistical systems and then on the analysis of these systems. Problems with hints for solution help the students to deepen their knowledge. The second edition has been updated and enlarged with new material on estimators based on a probability distribution for the parameters, identification of stochastic models from observations, and statistical tests and classification methods (Chaps. 10-12). Moreover, a customized set of problems with solutions is accessible on the Web. The author teaches and conducts research on stochastic dynamical systems at the University of Freiburg, Germany.

In this revised and enlarged second edition, Tony Guénault provides a clear and refreshingly readable introduction to statistical physics. The treatment itself is self-contained and concentrates on an understanding of the physical ideas, without requiring a high level of mathematical sophistication. The book adopts a straightforward quantum approach to statistical averaging from the outset. The initial part of the book is geared towards explaining the equilibrium properties of a simple isolated assembly of particles. The treatment of gases gives full coverage to Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Statistics links microscopic and macroscopic phenomena, and requires for this reason a large number of microscopic elements like atoms. The results are values of maximum probability or of averaging. This introduction to statistical physics concentrates on the basic principles, and attempts to explain these in simple terms supplemented by numerous examples. These basic principles include the difference between classical and quantum statistics, a priori probabilities as related to degeneracies, the vital aspect of indistinguishability as compared with distinguishability in classical physics, the differences between conserved and non-conserved elements, the different ways of counting arrangements in the three statistics (Maxwell–Boltzmann, Fermi–Dirac, Bose–Einstein), the difference between maximization of the number of arrangements of elements, and averaging in the Darwin–Fowler method. Significant applications to solids, radiation and electrons in metals are treated in separate chapters, as well as Bose–Einstein condensation. This revised second edition contains an additional chapter on the Boltzmann transport equation along with appropriate applications. Also, more examples have been added throughout, as well as further references to literature.