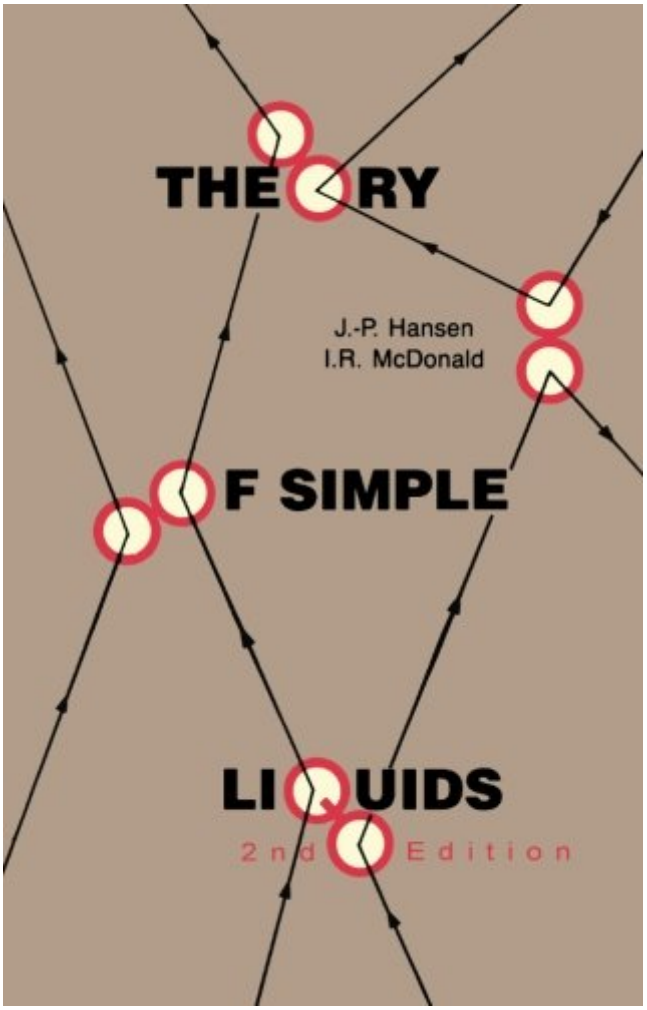

[PDF] Theory Of Simple Liquids, Second Edition

Eventually, you will categorically discover a further experience and attainment by spending more cash. still when? attain you take on that you require to get those all needs subsequently having significantly cash? Why dont you try to get something basic in the beginning? Thats something that will lead you to understand even more roughly speaking the globe, experience, some places, once history, amusement, and a lot more?

It is your very own become old to sham reviewing habit. in the middle of guides you could enjoy now is **Theory of Simple Liquids, Second Edition** below.

Theory of Simple Liquids-Jean-Pierre Hansen 1990-09-24 This book gives a comprehensive and up-to-date treatment of the theory of "simple" liquids. The new second edition has been rearranged and considerably expanded to give a balanced account both of basic theory and of the advances of the past decade. It presents the main ideas of modern liquid state theory in a way that is both pedagogical and self-contained. The book should be accessible to graduate students and research workers, both experimentalists and theorists, who have a good background in elementary mechanics. Compares theoretical deductions with experimental results Molecular dynamics Monte Carlo computations Covers ionic, metallic, and molecular liquids

Theory of Simple Liquids-Jean-Pierre Hansen 2006-02-08 The third edition of Theory of Simple Liquids is an updated, advanced, but self-contained introduction to the principles of liquid-state theory. It presents the modern, molecular theory of the structural, thermodynamic interfacial and dynamical properties of the liquid phase of materials constituted of atoms, small molecules or ions. This book leans on concepts and methods form classical Statistical Mechanics in which theoretical predictions are systematically compared with experimental data and results from numerical simulations. The overall layout of the book is similar to that of the previous two editions however, there are considerable changes in emphasis and several key additions including: •up-to-date presentation of modern theories of liquid-vapour coexistence and criticality •areas of considerable present and future interest such as super-cooled liquids and the glass transition •the area of liquid metals, which has grown into a mature subject area, now presented as part of the chapter ionic liquids •Provides cutting-edge research in the principles of liquid-state theory •Includes frequent comparisons of theoretical predictions with experimental and simulation data •Suitable for researchers and post-graduates in the field of condensed matter science (Physics, Chemistry, Material Science), biophysics as well as those in the oil industry

Nuclear Spin Relaxation in Liquids-Jozef Kowalewski 2017-12-14 Nuclear magnetic resonance (NMR) is widely used across many fields of science because of the rich data it produces, and some of the most valuable data come from studies of nuclear spin relaxation in solution. The first edition of this book, published more than a decade ago, provided an accessible and cohesive treatment of the field. The present second edition is a significant update, covering important new developments in recent years. Collecting relaxation theory, experimental techniques, and illustrative applications into a single volume, this book clarifies the nature of the phenomenon, shows how to study it and explains why such studies are worthwhile. Coverage ranges from basic to rigorous theory and from simple to sophisticated experimental methods. Topics include cross-relaxation, multispin phenomena, relaxation studies of molecular dynamics and structure and special topics such as relaxation in systems with quadrupolar nuclei, in paramagnetic systems and in long-living spin states. Avoiding overly demanding mathematics, the authors explain spin relaxation in a manner that anyone with a familiarity with NMR can follow. The focus is on illustrating and explaining the physical nature of

relaxation phenomena. Nuclear Spin Relaxation in Liquids: Theory, Experiments and Applications, 2nd edition, provides useful supplementary reading for graduate students and is a valuable reference for NMR spectroscopists, whether in chemistry, physics or biochemistry.

Many-Particle Physics-Gerald D. Mahan 2012-12-06 This textbook is for a course in advanced solid-state theory. It is aimed at graduate students in their third or fourth year of study who wish to learn the advanced techniques of solid-state theoretical physics. The method of Green's functions is introduced at the beginning and used throughout. Indeed, it could be considered a book on practical applications of Green's functions, although I prefer to call it a book on physics. The method of Green's functions has been used by many theorists to derive equations which, when solved, provide an accurate numerical description of many processes in solids and quantum fluids. In this book I attempt to summarize many of these theories in order to show how Green's functions are used to solve real problems. My goal, in writing each section, is to describe calculations which can be compared with experiments and to provide these comparisons whenever available. The student is expected to have a background in quantum mechanics at the level acquired from a graduate course using the textbook by either L. I. Schiff, A. S. Davydov, or I. Landau and E. M. Lifshiftz. Similarly, a prior course in solid-state physics is expected, since the reader is assumed to know concepts such as Brillouin zones and energy band theory. Each chapter has problems which are an important part of the lesson; the problems often provide physical insights which are not in the text. Sometimes the answers to the problems are provided, but usually not.

Statistical Mechanics of Liquids and Solutions-Roland Kjellander 2019-07-30 The statistical mechanical theory of liquids and solutions is a fundamental area of physical sciences with important implications for many industrial applications. This book shows how you can start from basic laws for the interactions and motions of microscopic particles and calculate how macroscopic systems of these particles behave, thereby explaining properties of matter at the scale that we perceive. Using this microscopic, molecular approach, the text emphasizes clarity of physical explanations for phenomena and mechanisms relevant to fluids, addressing the structure and behavior of liquids and solutions under various conditions. A notable feature is the author’s treatment of forces between particles that include nanoparticles, macroparticles, and surfaces. The book also provides an expanded, in-depth treatment of polar liquids and electrolytes.

Understanding the Properties of Matter-Michael de Podesta 2020-05-18 Understanding the Properties of Matter: 2nd Edition takes a unique phenomenological approach to the presentation of matter, materials, and solid-state physics. After an overview of basic ideas and a reminder of the importance of measurement, the author considers in turn gases, solids, liquids, and phase changes. For each topic, the focus is on "what happens." After a preliminary examination of data on the properties of matter, the author raises, then addresses a series of questions concerning the data. It is only in answering these questions that he adopts the theoretical approach to the properties of matter. This approach can reawaken in readers the fascination for the subject that inspired some of the greatest physicists of our age. Examples and extensive exercises reinforce the concepts. A supporting Web site furnishes for free download a plethora of additional materials, including: " Supplementary chapters on the band theory of solids and the magnetic properties of solids " Copies of all the data talbes used in the book, in PDF and spreadsheet formats " Enlarged copies of all figures " A simple molecular dynamics simulation " Animations uillustrating important featrues of key equations " Answers to the end-of-chapter exercises Understanding the Properties of Matter is an entertaining and innovative text accessible at the undergraduate level.

Statistical Mechanics of Nonequilibrium Liquids-Denis J. Evans 2007-08-01 "There is a symbiotic relationship between theoretical nonequilibrium statistical mechanics on the one hand and the theory and practice of computer simulation on the other. Sometimes, the initiative for progress has been with the pragmatic requirements of computer simulation and at other times, the initiative has been with the fundamental theory of nonequilibrium processes. This book summarises progress in this field up to 1990"--Publisher's description.

Quantum Theory of the Electron Liquid-Gabriele Giuliani 2005-03-31 Modern electronic devices and novel materials often derive their extraordinary properties from the intriguing, complex behavior of large numbers of electrons forming what is known as an electron liquid. This book provides an in-depth introduction to the physics of the interacting electron liquid in a broad variety of systems, including metals, semiconductors, artificial nano-structures, atoms and molecules. One, two and three dimensional systems are treated separately and in parallel. Different phases of the electron liquid, from the Landau Fermi liquid to the Wigner crystal, from the Luttinger liquid to the quantum Hall liquid are extensively discussed. Both static and time-dependent density functional theory are presented in detail. Although the emphasis is on the development of the basic physical ideas and on a critical discussion of the most useful approximations, the formal derivation of the results is highly detailed and based on the simplest, most direct methods.

Fluid Mechanics-L D Landau 2013-09-03 Fluid Mechanics, Second Edition deals with fluid mechanics, that is, the theory of the motion of liquids and gases. Topics covered range from ideal fluids and viscous fluids to turbulence, boundary layers, thermal conduction, and diffusion. Surface phenomena, sound, and shock waves are also discussed, along with gas flow, combustion, superfluids, and relativistic fluid dynamics. This book is comprised of 16 chapters and begins with an overview of the fundamental equations of fluid dynamics, including Euler's equation and Bernoulli's equation. The reader is then introduced to the equations of motion of a viscous fluid; energy dissipation in an incompressible fluid; damping of gravity waves; and the mechanism whereby turbulence occurs. The following chapters explore the laminar boundary layer; thermal conduction in fluids; dynamics of diffusion of a mixture of fluids; and the phenomena that occur near the surface separating two continuous media. The energy and momentum of sound waves; the direction of variation of quantities in a shock wave; one- and two-dimensional gas flow; and the intersection of surfaces of discontinuity are also also considered. This monograph will be of interest to theoretical physicists.

A General Relaxation Theory of Simple Liquids-Mati Merilo 1973 A relatively simple relaxation theory to account for the behavior of liquids under dynamic conditions was proposed. The general dynamical equations are similar in form to the phenomenological relaxation equations used in theories of viscoelasticity, however, they differ in that all the coefficients of the present equations are expressed in terms of thermodynamic and molecular quantities. The theory is based on the concept that flow in a liquid distorts both the radial and the velocity distribution functions, and that relaxation equations describing the return of these functions to their isotropic distributions, characterizing a stationary liquid, can be written. The theory was applied to the problems of steady and oscillatory shear flows and to the propagation of longitudinal waves. In all cases classical results are predicted for strain rates, and an expression for the viscosity of a liquid, simular to the Macedo-Litovitz equation, is obtained.

Intermolecular and Surface Forces-Jacob N. Israelachvili 2015-05-29 This reference describes the role of various intermolecular and interparticle forces in determining the properties of simple systems such as gases, liquids and solids, with a special focus on more complex colloidal, polymeric and biological systems. The book provides a thorough foundation in theories and concepts of intermolecular forces, allowing researchers and students to recognize which forces are important in any particular system, as well as how to control these forces. This third edition is expanded into three sections and contains five new chapters over the previous edition. · starts from the basics and builds up to more complex systems · covers all aspects of intermolecular and interparticle forces both at the fundamental and applied levels · multidisciplinary approach: bringing together and unifying phenomena from different fields · This new edition has an expanded Part III and new chapters on non-equilibrium (dynamic) interactions, and tribology (friction forces)

Computer Simulation of Liquids-M. P. Allen 1989 Computer simulation is an essential tool in studying the chemistry and physics of liquids. Simulations allow us to develop models and to test them against experimental data. This book is

an introduction and practical guide to the molecular dynamics and Monte Carlo methods.

Scientific and Technical Aerospace Reports-1971

Physical Review- 2000-12

Geometric Methods in the Elastic Theory of Membranes in Liquid Crystal Phases-Zhong-Can Ou-Yang 1999 This book contains a comprehensive description of the mechanical equilibrium and deformation of membranes as a surface problem in differential geometry. Following the pioneering work by W Helfrich, the fluid membrane is seen as a nematic or smectic ? A liquid crystal film and its elastic energy form is deduced exactly from the curvature elastic theory of the liquid crystals. With surface variation the minimization of the energy at fixed osmotical pressure and surface tension gives a completely new surface equation in geometry that involves potential interest in mathematics. The investigations of the rigorous solution of the equation that have been carried out in recent years by the authors and their co-workers are presented here, among which the torus and the discocyte (the normal shape of the human red blood cell) may attract attention in cell biology. Within the framework of our mathematical model by analogy with cholesteric liquid crystals, an extensive investigation is made of the formation of the helical structures in a tilted chiral lipid bilayer, which has now become a hot topic in the fields of soft matter and biomembranes.

Computer Simulation of Liquids-Michael P. Allen 2017-08-15 This book provides a practical guide to molecular dynamics and Monte Carlo simulation techniques used in the modelling of simple and complex liquids. Computer simulation is an essential tool in studying the chemistry and physics of condensed matter, complementing and reinforcing both experiment and theory. Simulations provide detailed information about structure and dynamics, essential to understand the many fluid systems that play a key role in our daily lives: polymers, gels, colloidal suspensions, liquid crystals, biological membranes, and glasses. The second edition of this pioneering book aims to explain how simulation programs work, how to use them, and how to interpret the results, with examples of the latest research in this rapidly evolving field. Accompanying programs in Fortran and Python provide practical, hands-on, illustrations of the ideas in the text.

Science Abstracts- 1985

Dynamics of Polymeric Liquids, Kinetic Theory-R. Byron Bird 1987-05-04

Mechanics of Liquids and Gases-L. G. Loitsyanskii 2014-07-18 Mechanics of Liquids and Gases, Second Edition is a 10-chapter text that covers significant revisions concerning the dynamics of an ideal gas, a viscous liquid and a viscous gas. After an expanded introduction to the fundamental properties and methods of the mechanics of fluids, this edition goes on dealing with the kinetics and general questions of dynamics. The next chapters describe the one-dimensional pipe flow of a gas with friction, the elementary theory of the shock tube; Riemann's theory of the wave propagation of finite intensity, and the theory of plane subsonic and supersonic flows. Other chapters consider the elements of the theory of three-dimensional subsonic and supersonic flows past bodies; the fluctuating laminar flow in a uniform pipe of circular cross-section; the hydrodynamic theory of lubrication; the variational principle of Helmholtz; and the theory of plane and axisymmetric laminar jets. The remaining chapters look into the semi-empirical theories of turbulence and their application in the analysis of axisymmetric jets, with and without swirl, and in the calculation of the resistance of rough plates. These chapters also discuss the dynamics of a viscous gas and the elements of the theory of laminar and turbulent boundary layers at high speeds. This book will be of value to mechanical engineers, physicists, and researchers.

A Textbook of Physical Chemistry-Arthur Adamson 2012-12-02 A Textbook of Physical Chemistry, Second Edition serves as an introductory text to physical chemistry. Topics covered range from wave mechanics and chemical bonding to molecular spectroscopy and photochemistry; ideal and nonideal gases; the three laws of thermodynamics; thermochemistry; and solutions of nonelectrolytes. The kinetics of

gas-phase reactions; colloids and macromolecules; and nuclear chemistry and radiochemistry are also discussed. This edition is comprised of 22 chapters; the first of which introduces the reader to the behavior of ideal and nonideal gases, with particular emphasis on the van der Waals equation. The discussion then turns to the kinetic molecular theory of gases and the application of the Boltzmann principle to the treatment of molar polarization; dipole and magnetic moments; the phenomenology of light absorption; and classical and statistical thermodynamics. The chapters that follow focus on the traditional sequence of chemical and phase equilibria, electrochemistry, and chemical kinetics in gas phase and solution phase. This book also considers wave mechanics and its applications; molecular spectroscopy and photochemistry; and the excited state, and then concludes with an analysis of crystal structure, colloid and polymer chemistry, and radio and nuclear chemistry. This reference material is intended primarily as an introductory text for students of physical chemistry.

Physics Briefs- 1991

Fundamentals of Inhomogeneous Fluids-Douglas Henderson 1992-08-28 A monograph examining recent progress in the field of inhomogeneous fluids, focusing on the theoretical - as well as experimental - techniques used. It presents the comprehensive theory of first-order phase transitions, including melting, and contains numerous figures, tables and display equations.;The contributors treat such subjects as: exact sum rules for inhomogenous fluids, explaining density functional and integral equation methods; exact solutions for two-dimensional homogeneous and inhomogeneous plasmas; current advances in the theory of interfacial electrochemistry; wetting experiments and the theory of wetting; freezing, with an emphasis on quantum systems and homogeneous nucleation in liquid-vapour and solid-liquid transitions; self-organizing liquids as well as kinetic phenomena in inhomogeneous fluids, using a modified Enskog theory.;Featuring over 1000 bibliographic citations, this volume is aimed at physical, surface, colloid and surfactant chemists; also physicists, electrochemists and graduate-level students in these disciplines.

Rheology-Aleksandr ÎÀkovlevich Malkin 2006 There are few comprehensive books on the market on the subject of rheology – the complex science dealing with flow and deformation of matter – and these are several years old. At last there is now a book that explains the meaning of a science that many scientists need to use but only a few can fully grasp. It does so by striking the balance between oversimplification and overload of theory in a very compelling and readable manner. The author's systematic presentation enables the authors to include all components of rheology in one volume. The first four chapters of this book discuss various aspects of theoretical rheology and, by examples of many studies, show how particular theory, model, or equation can be used in solving different problems. The main emphasis is on liquids, but solid materials are discussed in one full chapter as well. Methods of measurement and raw data treatment are included in one large chapter which constitutes more than one quarter of the book. Eight groups of methods are discussed giving many choices for experimentation and guidance on where and how to use them properly. The final chapter shows how to use rheological methods in different groups of products and methods of their manufacture. Usefulness of chemorheological (rheokinetical) measurements is also emphasized. This chapter continues with examples of purposeful applications in practical matters.

Genetics and Molecular Biology-Robert F. Schleif 1993 In the first edition of Genetics and Molecular Biology, renowned researcher and award-winning teacher Robert Schleif produced a unique and stimulating text that was a notable departure from the standard compendia of facts and observations. Schleif's strategy was to present the underlying fundamental concepts of molecular biology with clear explanations and critical analysis of well-chosen experiments. The result was a concise and practical approach that offered students a real understanding of the subject. This second edition retains that valuable approach--with material thoroughly updated to include an integrated treatment of prokaryotic and eukaryotic molecular biology. Genetics and Molecular Biology is copiously illustrated with two-color line art. Each chapter includes an extensive list of important references to the primary literature, as well as many innovative and thought-provoking problems on material covered in the text or on related topics. These

help focus the student's attention of a variety of critical issues. Solutions are provided for half of the problems. Praise for the first edition: "Schleif's Genetics and Molecular Biology... is a remarkable achievement. It is an advanced text, derived from material taught largely to postgraduates, and will probably be thought best suited to budding professionals in molecular genetics. In some ways this would be a pity, because there is also gold here for the rest of us... The lessons here in dealing with the information explosion in biology are that an ounce of rationale is worth a pound of facts and that, for educational value, there is nothing to beat an author writing about stuff he knows from theinside."--Nature. "Schleif presents a quantitative, chemically rigorous approach to analyzing problems in molecular biology. The text is unique and clearly superior to any currently available."--R.L. Bernstein, San Francisco State University. "The greatest strength is the author's ability to challenge the student to become involved and get below the surface."--Clifford Brunk, UCLA

Introduction to the Theory of Soft Matter-Jonathan V. Selinger 2015-08-19 This book presents the theory of soft matter to students at the advanced undergraduate or beginning graduate level. It provides a basic introduction to theoretical physics as applied to soft matter, explaining the concepts of symmetry, broken symmetry, and order parameters; phases and phase transitions; mean-field theory; and the mathematics of variational calculus and tensors. It is written in an informal, conversational style, which is accessible to students from a diverse range of backgrounds. The book begins with a simple “toy model” to demonstrate the physical significance of free energy. It then introduces two standard theories of phase transitions—the Ising model for ferromagnetism and van der Waals theory of gases and liquids—and uses them to illustrate principles of statistical mechanics. From those examples, it moves on to discuss order, disorder, and broken symmetry in many states of matter, and to explain the theoretical methods that are used to model the phenomena. It concludes with a chapter on liquid crystals, which brings together all of these physical and mathematical concepts. The book is accompanied online by a set of “interactive figures”—some allow readers to change parameters and see what happens to a graph, some allow readers to rotate a plot or other graphics in 3D, and some do both. These interactive figures help students to develop their intuition for the physical meaning of equations. This book will prepare advanced undergraduate or early graduate students to go into more advanced theoretical studies. It will also equip students going into experimental soft matter science to be fully conversant with the theoretical aspects and have effective collaborations with theorists.

Dissertation Abstracts International- 1993

General physics, relativity, astronomy and mathematical physics and methods- 1979

Advanced Statistical Mechanics-Barry M McCoy 2010 McCoy presents the advances made in statistical mechanics over the last 50 years, including mathematical theorems on order and phase transitions, numerical and series computations of phase diagrams and solutions for important solvable models such as Ising and 8 vortex.

Statistical Mechanics-Teunis C. Dorlas 2017-07-15 Suitable for advanced undergraduates and graduate students, this introductory approach's three-part treatment covers thermodynamics, fundamentals of statistical mechanics, and a detailed view of model applications. Includes problems with solutions. 1999 edition.

Fluid Mechanics-Pijush K. Kundu 2001-09-05 This is the most comprehensive introductory graduate or advanced undergraduate text in fluid mechanics available. It builds from the fundamentals, often in a very general way, to widespread applications to technology and geophysics. In most areas, an understanding of this book can be followed up by specialized monographs and the research literature. The material added to this new edition will provide insights gathered over 45 years of studying fluid mechanics. Many of these insights, such as universal dimensionless similarity scaling for the laminar boundary layer equations, are available nowhere else. Likewise for the generalized vector field derivatives. Other material, such as the generalized stream function treatment, shows

how stream functions may be used in three-dimensional flows. The CFD chapter enables computations of some simple flows and provides entrée to more advanced literature. *New and generalized treatment of similar laminar boundary layers. *Generalized treatment of streamfunctions for three-dimensional flow . *Generalized treatment of vector field derivatives. *Expanded coverage of gas dynamics. *New introduction to computational fluid dynamics. *New generalized treatment of boundary conditions in fluid mechanics. *Expanded treatment of viscous flow with more examples.

Non Linear Phenomena in Materials Science II-G. Martin 1992

Studies of Transport in Simple Fluids with the Moment Method-Mary Theodosopulu 1973

Ukrainian Physics Journal- 1967

Quantum Theory of Many-Particle Systems-Alexander L. Fetter 2012-03-08 Self-contained treatment of nonrelativistic many-particle systems discusses both formalism and applications in terms of ground-state (zero-temperature) formalism, finite-temperature formalism, canonical transformations, and applications to physical systems. 1971 edition.

Telegraphic Journal and Electrical Review-1874

Statistical Mechanics: Theory and Molecular Simulation-Mark Tuckerman 2010-02-11 Complex systems that bridge the traditional disciplines of physics, chemistry, biology, and materials science can be studied at an unprecedented level of detail using increasingly sophisticated theoretical methodology and high-speed computers. The aim of this book is to prepare burgeoning users and developers to become active participants in this exciting and rapidly advancing research area by uniting for the first time, in one monograph, the basic concepts of equilibrium and time-dependent statistical mechanics with the modern techniques used to solve the complex problems that arise in real-world applications. The book contains a detailed review of classical and quantum mechanics, in-depth discussions of the most commonly used ensembles simultaneously with modern computational techniques such as molecular dynamics and Monte Carlo, and important topics including free-energy calculations, linear-response theory, harmonic baths and the generalized Langevin equation, critical phenomena, and advanced conformational sampling methods. Burgeoning users and developers are thus provided firm grounding to become active participants in this exciting and rapidly advancing research area, while experienced practitioners will find the book to be a useful reference tool for the field.

Condensed Matter Field Theory-Alexander Altland 2010-03-11 Modern experimental developments in condensed matter and ultracold atom physics present formidable challenges to theorists. This book provides a pedagogical introduction to quantum field theory in many-particle physics, emphasizing the applicability of the formalism to concrete problems. This second edition contains two new chapters developing path integral approaches to classical and quantum nonequilibrium phenomena. Other chapters cover a range of topics, from the introduction of many-body techniques and functional integration, to renormalization group methods, the theory of response functions, and topology. Conceptual aspects and formal methodology are emphasized, but the discussion focuses on practical experimental applications drawn largely from condensed matter physics and neighboring fields. Extended and challenging problems with fully worked solutions provide a bridge between formal manipulations and research-oriented thinking. Aimed at elevating graduate students to a level where they can engage in independent research, this book complements graduate level courses on many-particle theory.

Cavitation and Bubble Dynamics-Christopher E. Brennen 2013-10-14 Cavitation and Bubble Dynamics deals with fundamental physical processes of bubble dynamics and cavitation for graduate students and researchers.

The Molecular Theory of Fluids-Herbert S. Green 1952

Solid-Liquid Separation-Ladislav Svarovsky 2013-10-22 Solid-Liquid Separation, Third Edition reviews the equipment and principles involved in the separation of solids and liquids from a suspension. Some important aspects of solid-liquid separation such as washing, flotation, membrane separation, and magnetic separation are discussed. This book is comprised of 23 chapters and begins with an overview of solid-liquid separation processes and the principles involved, including flotation, gravity sedimentation, cake filtration, and deep bed filtration. The following chapters focus on the characterization of particles suspended in liquids; the efficiency of separation of particles from fluids; coagulation and flocculation; gravity thickening; and the operating characteristics, optimum design criteria, and applications of hydrocyclones. The reader is also introduced to various solid-liquid separation processes such as centrifugal sedimentation, screening, and filtration, along with the use of filter aids. Countercurrent washing of solids and problems associated with fine particle recycling are also considered. The final chapter is devoted to the thermodynamics of particle-fluid interaction. This monograph will be useful to chemical engineers and process engineers, particularly those in plant operation, plant design, or equipment testing and commissioning. It can also be used as a textbook for both undergraduate and postgraduate students.