Plasma Physics Via Computer Simulation Series In Plasma Physics

This book contains MATLAB programs to demonstrate the numerical algorithms, the analytical approaches, and the physical principles. It starts with single particle, single fluid, and single wave, then the kinetic theory, the transport, the magnetohydrodynamics, and the nonlinear physics. The book emphasizes on the numerical algorithm and the analytical asymptology to tackle problems in plasma physics, and to demonstrate the underlying physics principles by graphical visualization. Students are introduced to the multiple time and multiple space scales as they learn the basic plasma phenomena, and are requested to solve problems with either MATLAB or C++. This book is targetting at the senior and graduate level. The emphasis of this book is to teach students to solve problems from the features and characteristics of the problem itself. It provides the students for the most important learning that is not knowing the solution, but knowing how to figure out the solution.

Solar-terrestrial physics deals with phenomena in the region of space between the surface of the Sun and the upper atmosphere of the Earth, a region dominated by matter in a plasma state. This area of physics describes processes that generate the solar wind, the physics of geospace and the Earth's magnetosphere, and the interaction of magnetospheri

This classic presentation has never been superseded in its encyclopedic coverage of the subject, and its excellent exposition of fundamental theorems, equations, and detailed methods of solution. Topics include many aspects of the dynamics of liquids and gases and 3-dimensional problems on motion of solids through a liquid. 1932 edition.

Complex plasmas differ from traditional plasmas in many ways: these are low-temperature high pressure systems containing nanometer to micrometer size particles which may be highly charged and strongly interacting. The particles may be chemically reacting or be in contact with solid surfaces, and the electrons may show quantum behaviour. These interesting properties have led to many applications of complex plasmas in technology, medicine and science. Yet complex plasmas are extremely complicated, both experimentally and theoretically, and require a variety of new approaches which go beyond standard plasma physics courses. This book fills this gap presenting an introduction to theory, experiment and computer simulation in this field. Based on tutorial lectures at a very successful recent Summer Institute, the presentation is ideally suited for graduate students, plasma physicists and experienced undergraduates.

Plasma Physics: An Introductory Course

Principles of Plasma Diagnostics

New Aspects of Plasma Physics

Theory and Practice

Plasma Physics Via Computer Simulation: Theory: plasma simulation using particles in spatial grids with finite time steps

The Plasma Boundary of Magnetic Fusion Devices introduces the physics of the plasma boundary region, including plasma-surface interactions, with an emphasis on those occurring in magnetically confined fusion plasmas. The book covers plasma-surface interaction, Debye sheaths, sputtering, scrape-off layers, plasma impurities, recycling and control, 1D and 2D fluid and kinetic modeling of particle transport, plasma properties at the edge, diverter and limiter physics, and control of the plasma boundary. Divided into three parts, the book begins with Part 1, an introduction to the plasma boundary. The derivations are heuristic and worked problems help crystallize physical intuition, which is emphasized throughout. Part 2 provides an introduction to methods of modeling the plasma edge region and for interpreting computer code results. Part 3 presents a collection of essays on currently active research hot topics. With an extensive bibliography and index, this book is an invaluable first port-of-call for researchers interested in plasma-surface interactions.

Divided into three main parts, the book guides the reader to an understanding of the basic concepts in this fascinating field of research. Part 1 introduces you to the fundamental concepts of simulation. It examines one-dimensional electrostatic codes and electromagnetic codes, and describes the numerical methods and analysis. Part 2 explores the mathematics and physics behind the algorithms used in Part 1. In Part 3, the authors address some of the more complicated simulations in two and three dimensions. The book introduces projects to encourage practical work Readers can download plasma modeling and simulation software — the ES1 program — with implementations for PCs and Unix systems along with the original FORTRAN source code. p-BodyText2Now available in paperback, Plasma Physics via Computer Simulation is an ideal complement to plasma physics courses and for self-study.

This authoritative text offers a complete overview on the statistical mechanics and electrodynamics of physical processes in dense plasma systems. The author emphasizes laboratory-based experiments and astrophysical observations of plasma phenomena, elucidated through the fundamentals. The coverage encompasses relevant condensed matter physics, atomic physics, nuclear physics, and astrophysics, including such key topics as phase transitions, transport, optical and nuclear processes. This essential resource also addresses exciting, cutting edge topics in the field, including metallic hydrogen, stellar and planetary magnetisms, pycnonuclear reactions, and gravitational waves. Scientists, researchers, and students in plasma physics, condensed matter physics, materials science, atomic physics, nuclear physics, and astrophysics will benefit from this work. Setsuo Ichimaru is a distinguished professor at the University of Tokyo, and has been a visiting member at The Institute for Advanced Study in Princeton, New Jersey, at the University of California, San Diego (UCSD), the Institute for Theoretical Physics at Johannes Kepler University, and the Max Planck Institute for Quantum Optics. He is a recipient of the Subramanyan Chandrasekhar Prize of Plasma Physics from the Association of Asia-Pacific Physical Societies and the Humboldt Research Award from the Alexander von Humboldt Foundation.

The research on gaseous electronics reaches back more than 100 years. With the growing importance of gas lasers in so many research and industrial applications as well as power systems generating, transmitting, and distributing huge blocks of electrical power, the body of literature on cross sections, drift and diffusion, and ionization phenomena c

Statistical Physics of Dense Plasmas

Computational Methods in Plasma Physics

Space Plasma Simulation

Hydrodynamics

Computer Applications in Plasma Science and Engineering

This volume, which contains 15 contributions, is based on a minicourse held at the 1987 IEEE Plasma Science Meeting. The purpose of the lectures in the course was to acquaint the students with the multidisciplinary nature of computational techniques and the breadth of research areas in plasma science in which computation can address important physics and engineering design issues. These involve: electric and magnetic fields, MHD equations, chemistry, radiation, ionization etc. The contents of the contributions, written subsequent to the minicourse, stress important aspects of computer applications. They are: 1) the numerical methods used; 2) the range of applicability; 3) how the methods are actually employed in research and in the design of devices; and, as a compendium, 4) the multiplicity of approaches possible for any one problem. The materials in this book are organized by both subject and applications which display some of the richness in computational plasma physics.

This work is a needed reference for widely used techniques and methods of computer simulation in physics and other disciplines, such as materials science. The work conveys both: the theoretical foundations of computer simulation as well as applications and "tricks of the trade", that often are scattered across various papers. Thus it will meet a need and fill a gap for every scientist who needs computer simulations for his/her task at hand. In addition to being a reference, case studies and exercises for use as course reading are included.

Divided into three main parts, the book guides the reader to an understanding of the basic concepts in this fascinating field of research. Part 1 introduces you to the fundamental concepts of simulation. It examines one-dimensional electrostatic codes and electromagnetic codes, and describes the numerical methods and analysis. Part 2 explores the mathematics and physics behind the algorithms used in Part 1. In Part 3, the authors address some of the more complicated simulations in two and three dimensions. The book introduces projects to encourage practical work Readers can download plasma modeling and simulation software — the ES1 program — with implementations for PCs and Unix systems along with the original FORTRAN source code. Now available in paperback, Plasma Physics via Computer Simulation is an ideal complement to plasma physics courses and for self-study.

Computer simulation of systems has become an important tool in scientific research and engineering design, including the simulation of systems through the motion of their constituent particles. Important examples of this are the motion of stars in galaxies, ions in hot gas plasmas, electrons in semiconductor devices, and atoms in solids and liquids. The behavior of the system is studied by programming into the computer a model of the system and then performing experiments with this model. New scientific insight is obtained by observing such computer experiments, often for controlled conditions that are not accessible in the laboratory. Computer Simulation using Particles deals with the simulation of systems by following the motion of their constituent particles. This book provides an introduction to simulation using particles based on the NGP, CIC, and P3M algorithms and the programming principles that assist with the preparations of large simulation programs based on the OLYMPUS methodology. It also includes case study examples in the fields of astrophysics, plasmas, semiconductors, and ionic solids as well as more detailed mathematical treatment of the models, such as their errors, dispersion, and optimization. This resource will help you understand how engineering design can be assisted by the ability to predict performance using the computer model before embarking on costly and time-consuming manufacture.

Fundamentals of Plasma Physics

Electron Dynamics of Diode Regions

Plasma Physics Via Computer Simulation

An Introduction

Plasma Physics for Controlled Fusion

This book provides a systematic introduction to the physics of plasma diagnostics measurements. It develops from first principles the concepts needed to plan, execute and interpret plasma measurements, making it a suitable book for graduate students and professionals with little plasma physics background. The book will also be a valuable reference for seasoned plasma physicists, both experimental and theoretical, as well as those with an interest in space and astrophysical applications. This second edition is thoroughly revised and updated, with new sections and chapters covering recent developments in the field.

Plasma engineering is a rapidly expanding area of science and technology with increasing numbers of engineers using plasma processes over a wide range of applications. An essential tool for understanding this dynamic field, Plasma Physics and Engineering provides a clear, fundamental introduction to virtually all aspects of modern plasma science and technology, including plasma chemistry and engineering, combustion, chemical physics, lasers, electronics, methods of material treatment, fuel conversion, and environmental control. The book contains an extensive database on plasma kinetics and thermodynamics, many helpful numerical formulas for practical calculations, and an array of problems and concept questions.

Looking for the real state of play in computational many-particle physics? Look no further. This book presents an overview of state-of-the-art numerical methods for studying interacting classical and quantum many-particle systems. A broad range of techniques and algorithms are covered, and emphasis is placed on their implementation on modern high-performance computers. This excellent book comes complete with online files and updates allowing readers to stay right up to date.

Electron Dynamics of Diode Regions describes the model construction and analysis of motion of charged particles of diode regions in time-varying fields. The models analyzed are simplified versions of parts of practical devices, primarily active microwave devices, tubes, and semiconductor amplifiers, while the most striking results obtained are due to electron inertia and space-charge effects in terms of laboratory observable. This book is composed of seven chapters, and begins with an introduction to the general concepts of time dependent flow, including induced current, the techniques of linearization, calculating variational transit time, and obtaining equivalent circuits. The following chapters present the classical linear analysis, which includes the space-charge effects, with several applications. These chapters also explore the existence of a maximum stable current in a space-charge limited diode. The discussion then shifts to the basics of high velocity, klystron, gap with nonuniform field distributions, and the application of the multicavity klystron. This text further covers the analysis and examples of crossed-field gaps. The final chapters deal with the fundamentals of velocity and current distributions obtained from common electron emitters, with some attempt to show how the multivelocity streams evolve into single-velocity equivalents needed for the methods of earlier chapters. Results of applying the Lagrangian starting analysis to semiconductor diode regions, necessarily from a new equation of motion, are also provided. This book is intended for graduate courses, seminars, and research studies.

Plasma Physics

Measurement Techniques in Space Plasmas

Elementary Processes and Phase Transitions

Electromagnetic Instabilities in an Inhomogeneous Plasma

Introduction to Complex Plasmas

This rigorous explanation of plasmas is relevant to diverse plasma applications such as controlled fusion, astrophysical plasmas, solar physics, magnetospheric plasmas, and plasma thrusters. More thorough than previous texts, it exploits new powerful mathematical techniques to develop deeper insights into plasma behavior. After developing the basic plasma equations from first principles, the book explores single particle motion with particular attention to adiabatic invariance. The author then examines types of plasma waves and the issue of Landau damping. Magnetohydrodynamic equilibrium and stability are tackled with emphasis on the topological concepts of magnetic helicity and self-organization. Advanced topics follow, including magnetic reconnection, nonlinear waves, and the Fokker-Planck treatment of collisions. The book concludes by discussing unconventional plasmas such as non-neutral and dusty plasmas. Written for beginning graduate students and advanced undergraduates, this text emphasizes the fundamental principles that apply across many different contexts.

The aim of this book is twofold: to provide an introduction for newcomers to state of the art computer simulation techniques in space plasma physics and an overview of current developments. Computer simulation has reached a stage where it can be a highly useful tool for guiding theory and for making predictions of space plasma phenomena, ranging from microscopic to global scales. The various articles are arranged, as much as possible, according to the - derlying simulation technique, starting with the technique that makes the least number of assumptions: a fully kinetic approach which solves the coupled set of Maxwell's equations for the electromagnetic ?eld and the equations of motion for a very large number of charged particles (electrons and ions) in this ?eld. Clearly, this is also the computationally most demanding model. Therefore, even with present day high performance computers, it is the most restrictive in terms of the space and time domain and the range of particle parameters that can be covered by the simulation experiments. It still makes sense, therefore, to also use models, which due to their simp- fying assumptions, seem less realistic, although the e?ect of these assumptions on the outcome of the simulation experiments needs to be carefully assessed.

Published by the American Geophysical Union as part of the Geophysical Monograph Series, Volume 102. Space plasma measurements are conducted in a hostile, remote environment. The art and science of measurements gathered in space depend therefore on unique instrument designs and fabrication methods to an extent perhaps unprecedented in experimental physics. In-situ measurement of space plasmas constitutes an expensive, unforgiving, and highly visible form of scientific endeavor.

This new edition presents the essential theoretical and analytical methods needed to understand the recent fusion research of tokamak and alternate approaches. The author describes magnetohydrodynamic and kinetic theories of cold and hot plasmas in detail. The book covers new important topics for fusion studies such as plasma transport by drift turbulence, which depend on the magnetic configuration and zonal flows. These are universal phenomena of microturbulence. They can modify the onset criterion for turbulent transport, instabilities driven by energetic particles as well as alpha particle generation and typical plasma models for computer simulation. The fusion research of tokamaks with various new versions of H modes are explained. The design concept of ITER, the international tokamak experimental reactor, is described for inductively driven operations as well as steady-state operations using non-inductive drives. Alternative approaches of reversed-field pinch and its relaxation process, stellator including quasi-symmetric system, open-end system of tandem mirror and inertial confinement are also explained. Newly added and updated topics in this second edition include zonal flows, various versions of H modes, and steady-state operations of tokamak, the design concept of ITER, the relaxation process of RFP, quasi-symmetric stellator, and tandem mirror. The book addresses graduate students and researchers in the field of controlled fusion.

Theory and Applications

Plasma Physics and Engineering

Numerical Methods for Hyperbolic and Kinetic Problems

Computer Simulation of Space Plasmas

Proceedings of the 2007 ICTP Summer College on Plasma Physics

Electromagnetic Instabilities in an Inhomogeneous Plasma presents a comprehensive survey of the theory of electromagnetic instabilities in a magnetized inhomogeneous plasma, mainly in the classical approximation of straight and parallel magnetic field lines as well as magnetic-field curvature effects. Using his expertise and experience, the author skillfully guides the reader through the theory; presenting the most important results from leading Russian and Western scientists. This timely and important work will enable new or experienced researchers to improve their knowledge of this important field of plasma research.

Hyperbolic and kinetic equations arise in a large variety of industrial problems. For this reason, the Summer Mathematical Research Center on Scientific Computing and its Applications (CEMRACS), held at the Center of International Research in Mathematics (CIRM) in Luminy, was devoted to this topic. During a six-week period, junior and senior researchers worked full time on several projects proposed by industry and academia. Most of this work was completed later on, and the present book reflects these results. The articles address modelling issues as well as the development and comparisons of numerical methods in different situations. The applications include multi-phase flows, plasma physics, quantum particle dynamics, radiative transfer, sprays, and aeroacoustics. The text is aimed at researchers and engineers interested in applications arising from modelling and numerical simulation of hyperbolic and kinetic problems.

Computational Science is the scientific discipline that aims at the development and understanding of new computational methods and techniques to model and simulate complex systems. The area of application includes natural systems - such as biology environ mental and geo-sciences, physics, and chemistry - and synthetic systems such as electronics and financial and economic systems. The discipline is a bridge bet ween 'classical' computer science - logic, complexity, architecture, algorithm- mathematics, and the use of computers in the aforementioned areas. The relevance for society stems from the numerous challenges that exist in the various science and engineering disciplines, which can be tackled by advances made in this field. For instance new models and methods to study environmental issues like

the quality of air, water, and soil, and weather and climate predictions through simulations, as well as the simulation-supported development of cars, airplanes, and medical and transport systems etc. Paraphrasing R. Kenway (R.D. Kenway, Contemporary Physics. 1994): 'There is an important message to scientists, politicians, and industrialists: in the future science, the best industrial design and manufacture, the greatest medical progress, and the most accurate environmental monitoring and forecasting will be done by countries that most rapidly exploit the full potential of computational science'. Nowadays we have access to high-end computer architectures and a large range of computing environments, mainly as a consequence of the enormous sti mulus from the various international programs on advanced computing, e.g.

Computer simulation is now widely recognized as a powerful tool and useful method at the current stage of research in space plasma physics. The expected role of computer simulation is to bridge the existing gap between theories and experiments/observations and to give a profound physical insight into highly tangled and nonlinearly coupled space plasma phenomena. One of the goals of space plasma physics in 1980's and 1990's is to elucidate the quantitative causal relationships of global and local energy flows in space plasma environment and establish the space plasma physics via cooperative studies among three important elements of observations, theories and computer simulations. Based on such recognition, Dr. M. Ashour-Abdalla (UCLA/USA), Dr. R. Gendrin (CNET/FRANCE) and both of us met together at the 20th General Assembly of URSI at Washington D. C. in 1981 to discuss what we should do and what we could do, reaching a conclusion that it is time to establish an International School of Space Simulations (ISSS). The objectives of the ISSS thus organized are firstly to educate and stimulate graduate students and young sCientists, secondly to exchange information on updated simulation techniques and thirdly to have mutual discussions among observational, theoretical and simulational scientists in the field of space physics. The first ISSS were organized by Prof. P. Coleman, Prof. T. Obayashi, Dr. H. Okuda in addition to the above four members. The first ISSS was held at Kansai Seminar House in Kyoto from Nov. I to Nov. 12, 1982.

Principles of Plasma Physics

Computer Simulation in Physics and Engineering

Plasma Physics and Controlled Nuclear Fusion

Computer Simulation Using Particles

Plasma Physics via Computer Simulation

A comprehensive description of hybrid plasma simulation models providing a very useful summary and guide to the vast literature on this topic.

The physics of plasmas is an extremely rich and complex subject as the variety of topics addressed in this book demonstrates. This richness and complexity demands new and powerful techniques for investigating plasma physics. An outgrowth from his graduate course teaching, now with corrections, Tajima's text provides not only a lucid introduction to computational plasma physics, but also offers the reader many examples of the way numerical modeling, properly handled, can provide valuable physical understanding of the nonlinear aspects so often encountered in both laboratory and astrophysical plasmas. Included here are computational methods for modern nonlinear physics as applied to hydrodynamic turbulence, solitons, fast reconnection of magnetic fields, anomalous transports, dynamics of the sun, and more. The text contains examples of problems now solved using computational techniques including those concerning finite-size particles, spectral techniques, implicit differencing, gyrokinetic approaches, and particle simulation.

Resulting from ongoing, international research into fusion processes, the International Tokamak Experimental Reactor (ITER) is a major step in the quest for a new energy source.The first graduate-level text to cover the details of ITER, Controlled Fusion and Plasma Physics introduces various aspects and issues of recent fusion research activ

Encompasses the Lectured Works of a Renowned Expert in the FieldPlasma Physics: An Introduction is based on a series of university course lectures by a leading name in the field, and thoroughly covers the physics of the fourth state of matter. This book looks at non-relativistic, fully ionized, nondegenerate, quasi-neutral, and weakly coupled plasm

The Hybrid Multiscale Simulation Technology

The Theory of ULF Waves and their Interaction with Energetic Particles in the Solar-Terrestrial Environment

Visual and Computational Plasma Physics

Magnetohydrodynamic Waves in Geospace

Particles

A wide-ranging introduction to the theoretical and experimental study of plasmas and their applications.

The OC 2007 ICTP Summer College on Plasma Physics" was held at the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy, during the period 30 July to 24 August 2007. The purpose of the summer college was to provide training for young scientists from all over the world, mainly from third world countries, and to give them the opportunity to interact with senior scientists in an informal manner. A large number of talks were given by invited speakers and experts, with information about the most recent advances in magnetic confinement fusion and tokamak physics, intense laserOCoplasma interactions and plasma-based particle acceleration, turbulence, dusty plasmas, and the emerging field of quantum plasmas. A selected number of papers from the invited speakers appear in this book. Sample Chapter(s). Foreword (60 KB). Nonlinear Collective Processes in Very Dense Plasmas (1,782 KB). Contents: Nonlinear Collective Processes in Very Dense Plasmas (P K Shukla et al.); Quantum, Spin and QED Effects in Plasmas (G Brodin & M Marklund); Quantum Methodologies in Beam, Fluid and Plasma Physics (R Fedele); Generation of Galactic Seed Magnetic Fields (H Saleem); Multifluid Theory of Solitons (F Verheest); Electro-Acoustic Solitary Waves in Dusty Plasmas (A A Mamun & P K Shukla); Physics of Dust in Magnetic Fusion Devices (Z Wang et al.); Short Wavelength Ballooning Mode in Tokamaks (A Hirose & N Joiner); and other papers. Readership: Researchers in the field of plasma physics."

Assuming no prior knowledge of plasma physics or numerical methods, Computational Methods in Plasma Physics covers the computational mathematics and techniques needed to simulate magnetically confined plasmas in modern magnetic fusion experiments and future magnetic fusion reactors. Largely self-contained, the text presents the basic concepts neces

The primary objectives of this book are, firstly, to present the essential theoretical background needed to understand recent fusion research and, secondly, to describe the current status of fusion research for graduate students and senior undergraduates. It will also serve as a useful reference for scientists and engineers working in the related fields. In Part I, Plasma Physics, the author explains the basics of magneto-hydrodynamics and kinetic theory in a simple and compact way and, at the same time, covers important new topics for fusion studies such as the ballooning representation, instabilities driven by energetic particles and various plasma models for computer simulations. Part II, Controlled Nuclear Fusion, attempts to review the "big picture" in fusion research. All important phenomena and technologies are addressed, with a particular emphasis on the topics of most concern in current research.

Controlled Fusion and Plasma Physics

CEMRACS 2003, Summer Research Center in Mathematics and Advances in Scientific Computing, July 21- August 29, 2003, CIRM, Marseille, France

The Plasma Boundary of Magnetic Fusion Devices

Gaseous Electronics

With Applications To Fusion And Astrophysics

Plasma Physics via Computer SimulationCRC Press

International Conference Amsterdam, The Netherlands, April 21–24, 2002 Proceedings

Computational Plasma Physics

Computational Science — ICCS 2002

Computational Many-Particle Physics

Numerical "Particle-in-Cell" Methods