Chen Plasma Physics Solutions

Fundamentals of Plasma Physics is a general introduction designed to present a comprehensive, logical and unified treatment of the fundamentals of plasma physics based on statistical kinetic theory, with applications to a variety of important plasma phenomena. Its clarity and completeness makes the text suitable for self-learning and for self-paced courses. Throughout the text the emphasis is on clarity, rather than formality, the various derivations are explained in detail and, wherever possible, the physical interpretations are emphasized. The mathematical treatment is set out in great detail, carrying out the steps which are usually left to the reader. The problems form an integral part of the text and most of them were designed in such a way as to provide a guideline, stating intermediate steps with answers.

Ron DiPippo, Professor Emeritus at the University of Massachusetts Dartmouth, is a world-regarded geothermal expert. This single resource covers all aspects of the utilization of geothermal energy for power generation from fundamental scientific and engineering principles. The thermodynamic basis for the design of geothermal power plants is at the heart of the book and readers are clearly guided on the process of designing and analysing the key types of geothermal energy conversion systems. Its practical

emphasis is enhanced by the use of case studies from real plants that increase the reader's understanding of geothermal energy conversion and provide a unique compilation of hard-to-obtain data and experience. An important new chapter covers Environmental Impact and Abatement Technologies, including gaseous and solid emissions; water, noise and thermal pollutions; land usage; disturbance of natural hydrothermal manifestations, habitats and vegetation; minimisation of CO2 emissions and environmental impact assessment. The book is illustrated with over 240 photographs and drawings. Nine chapters include practice problems, with solutions, which enable the book to be used as a course text. Also includes a definitive worldwide compilation of every geothermal power plant that has operated, unit by unit, plus a concise primer on the applicable thermodynamics. * Engineering principles are at the heart of the book, with complete coverage of the thermodynamic basis for the design of geothermal power systems * Practical applications are backed up by an extensive selection of case studies that show how geothermal energy conversion systems have been designed, applied and exploited in practice * World renowned geothermal expert DiPippo has including a new chapter on Environmental Impact and Abatement Technology in this new edition

This book covers the basic principles of both fusion

and plasma physics, examining their combined application for driving controlled thermonuclear energy. The author begins by explaining the underlying scientific theory, and then goes on to explore the nuances of deployment within thermonuclear reactors. The potential for these technologies to help shape the new generation of clean energy is examined in-depth, encompassing perspectives both highlighting benefits, and warning of challenges associated with the nuclear fusion pathway. The associated computer code and numerical analysis are included in the book. No prior knowledge of plasma physics or fusion is required. At Les Houches in January 2015, experts in the field of charged particle trapping came together for the Second Winter School on Physics with Trapped Charged Particles. This textbook collates the lectures delivered there, covering the fundamental physics of particle traps and the different types of applications of these devices. Taken as a whole, the book gives an overview of why traps for charged particles are important, how they work, their special features and limitations, and their application in areas such as precision measurements, mass spectrometry, optical clocks, plasma physics, antihydrogen creation, quantum simulation and quantum information processing. Chapters from various world experts include those on the basic properties of Penning traps and RF traps, as well as

those covering important practical aspects such as vacuum systems, detection techniques, and different types of particle cooling, including laser cooling. Each individual chapter provides information and guidance on the application of the above methods. Additionally, each chapter is complemented by fully worked problems and solutions, making Trapped Charged Particles perfect for advanced undergraduate and postgraduate students new to this topic. Contents:Penning TrapsRadiofrequency TrapsThe Guiding Center ApproximationToroidal SystemsUltrahigh Vacuum for Trapped IonsLaser Cooling Techniques Applicable to Trapped IonsNon-Laser Cooling TechniquesNumerical Simulations of Ion Cloud DynamicsPlasmas in Penning TrapsPlasma ModesRotating Wall Technique and Centrifugal SeparationCorrelations in Trapped PlasmaAutoresonanceAntihydrogen PhysicsIon Coulomb Crystals and Their ApplicationsCold Molecular Ions in TrapsPrecise Tests of Fundamental Symmetries with Trapped IonsTrapped-Ion Optical Frequency Standards Readership: Advanced undergraduate and postgraduate students studying the field of trapped charged particles.
This book grew out of lecture notes for an undergraduate course in plasma physics that has been offered for a number of years at UCLA. With the current increase in interest in controlled fusion and the wide spread use of plasma physics in space

research and relativistic as trophysics, it makes sense for the study of plasmas to become a part of an undergraduate student's basic experience, along with subjects like thermodynamics or quantum mechanics. Although the primary purpose of this book was to fulfill a need for a text that seniors or juniors can really understand, I hope it can also serve as a painless way for scientists in other fields-solid state or laser physics, for instance to become acquainted with plasmas. Two guiding principles were followed: Do not leave algebraic steps as an exercise for the reader, and do not let the algebra obscure the physics. The extent to which these opposing aims could be met is largely due to the treatment of a plasma as two interpenetrating fluids. The two-fluid picture is both easier to understand and more accurate than the single-fluid approach, at least for low-density plasma phe nomena.

TO THE SECOND EDITION In the nine years since this book was first written, rapid progress has been made scientifically in nuclear fusion, space physics, and nonlinear plasma theory. At the same time, the energy shortage on the one hand and the exploration of Jupiter and Saturn on the other have increased the national awareness of the important applications of plasma physics to energy production and to the understanding of our space environment. In magnetic confinement fusion, this period has seen the attainment 13 of a Lawson number nTE of 2 x 10

cm -3 sec in the Alcator tokamaks at MIT; neutral-beam heating of the PL T tokamak at Princeton to KTi = 6. 5 keV; increase of average ß to 3%-5% in tokamaks at Oak Ridge and General Atomic; and the stabilization of mirror-confined plasmas at Livermore, together with injection of ion current to near field-reversal conditions in the 2XIIß device. Invention of the tandem mirror has given magnetic confinement a new and exciting dimension. New ideas have emerged, such as the compact torus, surface-field devices, and the EßT mirror-torus hybrid, and some old ideas, such as the stellarator and the reversed-field pinch, have been revived. Radiofrequency heat ing has become a new star with its promise of dc current drive. Perhaps most importantly, great progress has been made in the understanding of the MHD behavior of toroidal plasmas: tearing modes, magnetic Vll Vlll islands, and disruptions.
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This monograph has grown out of research we started in 1987, although the foun dations were laid in the 1970's when both of us were working on our doctoral theses, trying to generalize the now classic paper of Oleinik, Kalashnikov and Chzhou on nonlinear degenerate diffusion. Brian worked under the guidance of Bert

Peletier at the University of Sussex in Brighton, England, and, later at Delft University of Technology in the Netherlands on extending the earlier mathematics to include nonlinear convection; while Robert worked at Lomonosov State Univer sity in Moscow under the supervision of Anatolii Kalashnikov on generalizing the earlier mathematics to include nonlinear absorption. We first met at a conference held in Rome in 1985. In 1987 we met again in Madrid at the invitation of Ildefonso Diaz, where we were both staying at 'La Residencia'. As providence would have it, the University 'Complutense' closed down during this visit in response to student demonstra tions, and, we were very much left to our own devices. It was natural that we should gravitate to a research topic of common interest. This turned out to be the characterization of the phenomenon of finite speed of propagation for nonlin ear reaction-convection-diffusion equations. Brian had just completed some work on this topic for nonlinear diffusion-convection, while Robert had earlier done the same for nonlinear diffusion-absorption. There was no question but that we bundle our efforts on the general situation.

A Nobel Foundation Symposium on the subject: "Nonlinear Effects 1n Plasmas", was held at Aspenasgarden, Lerum, in the G6teborg area of Sweden from June 11-17, 1976. The Symposium was the 36th in the series of Nobel Foundation Symposia, which have been held mainly within the areas of physics, chemistry, medicine, literature and peace prizes. Some 30 leading experts from the United States, Soviet Union, Japan and Western Europe attended the Symposium. The purpose

of the Symposium was to discuss various topics in the field of modern plasma physics. We had to select from this vast area of active research a suitable common theme with a great number of new and interesting contributions. We decided to devote our Sym posium in particular to nonlinear effects in plasmas and to emphasize some areas where important developments seemed to be taking place. In recent years basic theory and experiments in nonlinear plasma physics have been stimulated largely by the need for an energy source based on fusion of light nuclei. In many laboratories all over the world attempts are being made to come closer to the final goal by studying magnetically confined plasmas and systems of inertial con finement. Heating of plasmas to fusion temperatures remains a key problem. There are good reasons to believe that the nonlinear effects in plasmas will play an important role for fusion, a long-range program which is still largely in its basic research phase.

This volume gives a broad synthesis of the current knowledge and understanding of the plasma physics behind the aurora. The aurora is not only one of the most spectacular natural phenomena on Earth, but the underlying physical processes are expected to be ubiquitous in the plasma universe. Recognizing the enormous progress made over the last decade) through in situ and groundbased measurements as well as theoretical modelling, it seemed timely to write the first comprehensive and integrated book on the subject. Recent advances concern the clarification of the nature of the acceleration process of the electrons that are

responsible for the visible aurora, the recognition of the fundamental role of the large-scale current systems in organizing the auroral morphology, and of the interplay between particles and electromagnetic fields.

The topics covered in these notes are selective and tend to emphasize more on kinetic-theory approaches to waves and instabilities in both uniform and non-uniform plasmas, students are assumed to have some basic knowledge of plasma dynamics in terms of single-particle and fluid descriptions.

Covers the basic concepts of plasma physics

This book builds on the fluid and kinetic theory of equilibria and waves presented in a companion textbook, Basic Space Plasma Physics (by the same authors), but can also serve as a stand-alone text. It extends the field covered there into the domain of plasma instability and nonlinear theory.The book provides a representative selection of the many possible macro- and microinstabilities in a space plasma, from the Rayleigh-Taylor and Kelvin-Helmholtz to electrostatic and electromagnetic kinetic instabilities. Their quasilinear stabilization and nonlinear evolution and their application to space physics problems are treated. The chapters on nonlinear theory include nonlinear waves, weak turbulence and strong turbulence, all presented from the viewpoint of their relevance to space plasma physics. Special topics include auroral particle acceleration, soliton formation and caviton collapse, anomalous transport, and the theory of collisionless shocks.

This book on Advance Elements of Laser circuits and systems Nonlinearity applications in engineering

addresses two separate engineering and scientific areas, and presents advanced analysis methods for Laser circuits and systems that cover a broad range of engineering and scientific applications. The book analyzed Laser circuits and systems as linear and nonlinear dynamical systems and there limit cycles, bifurcation, and limit cycle stability by using nonlinear dynamic theory. Further, it discussed a broad range of bifurcations related to Laser systems and circuits, starting from laser system differential equations and their bifurcations, delay differential equations (DDEs) are a function of time delays, delay dependent parameters, followed by phase plane analysis, limit cycles and their bifurcations, chaos, iterated maps, period doubling. It combines graphical information with analytical analysis to effectively study the local stability of Laser systems models involving delay dependent parameters. Specifically, the stability of a given steady state is determined by the graphs of some functions of which can be expressed explicitly. The Laser circuits and systems are Laser diode circuits, MRI system Laser diode circuitry, Electron-photon exchanges into VCSEL, Ti: Sapphire laser systems, Ion channel and long-wavelength lasers, Solid state lasers, Solid state laser controlled by semiconductor devices, microchip solid-state laser, Q-switched diode-pumped solid-state laser, Nd:YAG, Mid-Infrared and Q-switched microchip lasers, Gas laser systems, copper vapor laser (CVL) circuitry, Dual-wavelength laser systems, Dual-wavelength operation of a Ti:sapphire laser, Diode-pumped Q-switched Nd:YVO4 yellow laser, Asymmetric dual

quantum well lasers, Tm3+-doped silica fibre lasers, Terahertz dual-wavelength quantum cascade laser. The Book address also the additional areas, Laser X guiding system, Plasma diagnostics, Laser Beam shaping, Jitter and crosstalk, Plasma mirror systems, and High power Laser/Target diagnostic system optical elements. The book is unique in its emphasis on practical and innovative engineering and scientific applications. All conceptual Laser circuits are innovative and can be broadly implemented in many engineering applications. The dynamics of Laser circuits and systems provides several ways to use them in a variety of applications covering wide areas. This book is aimed at electrical and electronics engineers, students and researchers in physics as well. It is also aimed for research institutes in lasers and plasma physics and gives good comprehensive in laser and plasma systems. In each chapter, the concept is developed from basic assumptions up to the final engineering and scientific outcomes. The scientific background is explained at basic and advance levels and closely integrated with mathematical theory. Many examples are presented in this book and it is also ideal for intermediate level courses at graduate level studies. It is also ideal for engineer who has not had formal instruction in nonlinear dynamics, but who now desires to fill the gap between innovative Laser circuits/systems and advance mathematical analysis methods

This Special Issue aims to be a compilation of new results in the areas of differential and difference Equations, covering boundary value problems,

systems of differential and difference equations, as well as analytical and numerical methods. The objective is to provide an overview of techniques used in these different areas and to emphasize their applicability to real-life phenomena, by the inclusion of examples. These examples not only clarify the theoretical results presented, but also provide insight on how to apply, for future works, the techniques used.

Stringent industrial requirements of sophisticated performances and of circumstantial control for micro-devices or nanotechnology manufactures, and other types of machinery at multiple scales, can be satisfied often only by resort to or allowance for complex materials. The adjective 'complex' beckons to the fact that the substructure influences gross mechanical behaviour in a prominent way and interactions due to substructural changes are represented directly. The description of the mechanical behaviour of complex bodies proposes a wide class of challenging problems from macroscopic-to-nano-world. The collection of chapters composing this book aims to explore some aspects of these problems, proposing also new matter of discussion together with specific solutions. Contributors are Carlo Cercignani, Gianfranco Capriz, Pierre Degond, Antonio Fasano, Harley T. Johnson, Sukky Jun, Krishna Kannan, Wing Kam Liu, Alberto Mancini, Paolo Maria Mariano, Ingo

Müller, Kumbakonan R. Rajagopal, Jan Jerzy Slawianowski. The book can be a useful tool for Scholars and PhD students addressing their research activity toward basic mathematical and physical problems accruing from the mechanics of materials.

With this book, we aim to capture different perspectives of researchers on nonlinear optics and optical devices and we intend to cover the latest developments in optics from theoretical, numerical, and experimental aspects. The eleven selected chapters cover a variety of topics related to nonlinear optics including bright, dark, kink solitary waves in various media, magnetic solitons, lattice solitons, rogue-waves, solid-state lasers, laser cladding, optical sensors, optical vortices, and molecular switches. The book is intended to draw the attention of scientists in academia, as well as researchers and engineers in industry, since the field has a significant potential for the production and design of novel optical devices and other technological applications.

Recent books have raised the public consciousness about the dangers of global warming and climate change. This book is intended to convey the message that there is a solution. The solution is the rapid development of hydrogen fusion energy. This energy source is inexhaustible and, although achieving fusion energy is difficult, the progress made in the past two decades has been remarkable.

The physics issues are now understood well enough that serious engineering can begin.The book starts with a summary of climate change and energy sources, trying to give a concise, clear, impartial picture of the facts, separate from conjecture and sensationalism. Controlled fusion -- the difficult problems and ingenious solutions -- is then explained using many new concepts.The bottom line -- what has yet to be done, how long it will take, and how much it will cost -- may surprise you. Francis F. Chen's career in plasma has extended over five decades. His textbook Introduction to Plasma Physics has been used worldwide continuously since 1974. He is the only physicist who has published significantly in both experiment and theory and on both magnetic fusion and laser fusion. As an outdoorsman and runner, he is deeply concerned about the environment. Currently he enjoys bird photography and is a member of the Audubon Society.

A comprehensive textbook on the foundational principles of plasmas, including material on advanced topics and related disciplines such as optics, fluid dynamics, and astrophysics Foundations of Plasma Physics for Physicists and Mathematicians covers the basic physics underlying plasmas and describes the methodology and techniques used in both plasma research and other disciplines such as optics and fluid mechanics.

Designed to help readers develop physical understanding and mathematical competence in the subject, this rigorous textbook discusses the underlying theoretical foundations of plasma physics as well as a range of specific problems, focused on those principally associated with fusion. Reflective of the development of plasma physics, the text first introduces readers to the collective and collisional behaviors of plasma, the single particle model, wave propagation, the kinetic effects of gases and plasma, and other foundational concepts and principles. Subsequent chapters cover topics including the hydrodynamic limit of plasma, ideal magneto-hydrodynamics, waves in MHD plasmas, magnetically confined plasma, and waves in magnetized hot and cold plasma. Written by an acknowledged expert with more than five decades' active research experience in the field, this authoritative text: Identifies and emphasizes the similarities and differences between plasmas and fluids Describes the different types of interparticle forces that influence the collective behavior of plasma Demonstrates and stresses the importance of coherent and collective effects in plasma Contains an introduction to interactions between laser beams and plasma Includes supplementary sections on the basic models of low temperature plasma and the theory of complex variables and Laplace transforms Foundations of Plasma Physics for Physicists and

Mathematicians is the ideal textbook for advanced undergraduate and graduate students in plasma physics, and a valuable compendium for physicists working in plasma physics and fluid mechanics.
IMA Volumes 135: Transport in Transition Regimes and 136: Dispersive Transport Equations and Multiscale Models focus on the modeling of processes for which transport is one of the most complicated components. This includes processes that involve a wdie range of length scales over different spatio-temporal regions of the problem, ranging from the order of mean-free paths to many times this scale. Consequently, effective modeling techniques require different transport models in each region. The first issue is that of finding efficient simulations techniques, since a fully resolved kinetic simulation is often impractical. One therefore develops homogenization, stochastic, or moment based subgrid models. Another issue is to quantify the discrepancy between macroscopic models and the underlying kinetic description, especially when dispersive effects become macroscopic, for example due to quantum effects in semiconductors and superfluids. These two volumes address these questions in relation to a wide variety of application areas, such as semiconductors, plasmas, fluids, chemically reactive gases, etc.
Plasma as the fourth state of matter is an ionized gas consisting of both negative and positive ions,

electrons, neutral atoms, radicals, and photons. In the last few decades, atmospheric-pressure plasmas have started to attract increasing attention from both scientists and industry due to a variety of potential applications. Because of increasing interest in the topic, the focus of this book is on providing engineers and scientists with a fundamental understanding of the physical and chemical properties of different atmospheric-pressure plasmas via plasma diagnostic techniques and their applications. The book has been organized into two parts. Part I focuses on the latest achievements in advanced diagnostics of different atmospheric-pressure plasmas. Part II deals with applications of different atmospheric-pressure plasmas.

Adopting a proactive approach and focusing on emerging radiation-generating technologies, Health Physics in the 21st Century meets the growing need for a presentation of the relevant radiological characteristics and hazards. As such, this monograph discusses those technologies that will affect the health physics and radiation protection profession over the decades to come. After an introductory overview, the second part of this book looks at fission and fusion energy, followed by a section devoted to accelerators, while the final main section deals with radiation on manned space missions. Throughout, the author summarizes the relevant technology and scientific basis, while

providing over 200 problems plus solutions to illustrate and amplify the text. Twelve appendices add further background material to support and enrich the topics addressed in the text, making this invaluable reading for students and lecturers in physics, biophysicists, clinical, nuclear and radiation physicists, as well as physicists in industry.
Plasma Engineering is the first textbook that addresses plasma engineering in the aerospace, nanotechnology, and bioengineering fields from a unified standpoint. It covers the fundamentals of plasma physics at a level suitable for an upper level undergraduate or graduate student, and applies the unique properties of plasmas (ionized gases) to improve processes and performance over a wide variety of areas such as materials processing, spacecraft propulsion, and nanofabrication. The book starts by reviewing plasma particle collisions, waves, and instabilities, and proceeds to diagnostic tools, such as planar, spherical, and emissive probes, and the electrostatic analyzer, interferometric technique, and plasma spectroscopy. The physics of different types of electrical discharges are considered, including the classical Townsend mechanism of gas electrical breakdown and the Paschen law. Basic approaches and theoretical methodologies for plasma modeling are described, based on the fluid description of plasma solving numerically magnetohydrodynamic (MHD) equations

and the kinetic model particle techniques that take into account kinetic interactions among particles and electromagnetic fields. Readers are then introduced to the widest variety of applications in any text on the market, including space propulsion applications and application of low-temperature plasmas in nanoscience and nanotechnology. The latest original results on cold atmospheric plasma (CAP) applications in medicine are presented. The book includes a large number of worked examples, end of chapter exercises, and historical perspectives. There is also an accompanying plasma simulation software covering the Particle in Cell (PIC) approach, available at http://www.particleincell.com/blog/2011/particle-in-cell-example/. This book is appropriate for grad level courses in Plasma Engineering/Plasma Physics in departments of Aerospace Engineering, Electrical Engineering, and Physics. It will also be useful as an introduction to plasma engineering and its applications for early career researchers and practicing engineers. The first textbook that addresses plasma engineering in the aerospace, nanotechnology, and bioengineering fields from a unified standpoint Includes a large number of worked examples, end of chapter exercises, and historical perspectives Accompanying plasma simulation software covering the Particle in Cell (PIC) approach, available at http://www.particleincell.com/blog/2011/particle-in-cell-example/

Introducing the principles and applications of plasma physics, this new edition is ideal as an advanced undergraduate or graduate-level text.

This workshop gathered experts in plasma physics, nonlinear phenomena and mathematics. It aimed at enabling theoreticians and experimentalists in plasma turbulence to relate electromagnetic fluctuations to transport processes. It may lead to the development of new diagnostics and new methods for signal processing.

Introduction to Plasma Physics and Controlled FusionSpringer

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.

Recently, plasma spray has been received a large number of attentions for various type of applications due to the nature of the plasma plume and deposition structure. The plasma gas generated by the arc, consists of free electrons, ionized atoms, some neutral atoms, and undissociated diatomic molecules. The temperature of the core of the plasma jet may exceed up to 30,000 K. Gas velocity in the plasma spray torch can be varied from subsonic to supersonic using converging-diverging nozzles. Heat transfer in the plasma jet is primarily the result of the recombination of the ions and re-association of atoms in diatomic gases on the powder surfaces and absorption of radiation. Taking advantages of the plasma plume atmosphere, plasma spray can be used for surface modification and treatment, especially for activation of polymer surfaces. I addition, plasma spray can be used to deposit nanostructures as well as advanced coating structures for new applications in wear and corrosion resistance. Some state-of-the-art studies of advanced applications of plasma spraying such as nanostructure coatings, surface modifications, biomaterial deposition, and anti wear and corrosion coatings are presented in this book.

There has been an increase in interest worldwide in fusion

research over the last decade and a half due to the recognition that a large number of new, environmentally attractive, sustainable energy sources will be needed to meet ever increasing demand for electrical energy. Based on a series of course notes from graduate courses in plasma physics and fusion energy at MIT, the text begins with an overview of world energy needs, current methods of energy generation, and the potential role that fusion may play in the future. It covers energy issues such as the production of fusion power, power balance, the design of a simple fusion reactor and the basic plasma physics issues faced by the developers of fusion power. This book is suitable for graduate students and researchers working in applied physics and nuclear engineering. A large number of problems accumulated over two decades of teaching are included to aid understanding.

This complete introduction to plasma physics and controlled fusion by one of the pioneering scientists in this expanding field offers both a simple and intuitive discussion of the basic concepts of this subject and an insight into the challenging problems of current research. In a wholly lucid manner the work covers single-particle motions, fluid equations for plasmas, wave motions, diffusion and resistivity, Landau damping, plasma instabilities and nonlinear problems. For students, this outstanding text offers a painless introduction to this important field; for teachers, a large collection of problems; and for researchers, a concise review of the fundamentals as well as original treatments of a number of topics never before explained so clearly. This revised edition contains new material on kinetic effects, including Bernstein waves and the plasma dispersion function, and on nonlinear wave equations and solitons. For the third edition, updates was made throughout each existing chapter, and two new chapters were added; Ch 9 on “Special Plasmas” and Ch 10

on Plasma Applications (including Atmospheric Plasmas).
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