Dynamo And Dynamics A Mathematical Challenge

The book collects the most relevant results from the INdAM Workshop "Shocks, Singularities and Oscillations in Nonlinear Optics and Fluid Mechanics" held in Rome, September 14-18, 2015. The contributions discuss recent major advances in the study of nonlinear hyperbolic systems, addressing general theoretical issues such as symmetrizability, singularities, low regularity or dispersive perturbations. It also investigates several physical phenomena where such systems are relevant, such as nonlinear optics, shock theory (stability, relaxation) and fluid mechanics (boundary layers, water waves, Euler equations, geophysical flows, etc.). It is a valuable resource for researchers in these fields.

This book discusses a number of qualitative features of mathematical models of incompressible fluids. Three basic systems of hydrodynamical equations are considered: the system of stationary Euler equations for flows of an ideal (nonviscous) fluid, stationary Navier-Stokes equations for flows of a viscous fluid, and Reynolds equations for the mean velocity field, pressure, and pair one-point velocity correlations of turbulent flows. The analysis concerns algebraic or geometric properties of vector fields generated by these equations, such as the general arrangement of streamlines, the character and distribution of singular points, conditions for their absence or appearance, and so on. Troshkin carries out a systematic application of the analysis to

investigate conditions for unique solvability of a number of problems for these quasilinear systems. Containing many examples of particular phenomena illustrating the general ideas covered, this book will be of interest to researchers and graduate students working in mathematical physics and hydrodynamics.

Treaties on Geophysics: Core Dynamics, Volume 8, provides a comprehensive review of the current state of understanding of core dynamics. The book begins by analyzing a subject of long-standing and on-going controversy: the gross energetics of the core. It then explains the important elements of dynamo theory; actual fluid motions in the core; the basic physical principles involved in thermochemical convection in the core and the basic equations governing the convection; and turbulence and the small-scale dynamics of the core. This is followed by discussions of the state of knowledge on rotation-induced core flows; the use of first-principles numerical models of self-sustaining fluid dynamos; and the behavior of polarity reversals in numerical dynamo models. The remaining chapters cover the various roles the inner core plays in core dynamics and the geodynamo; experiments that have shaped knowledge about the flows in the core that produce the geodynamo and govern its evolution; and ways the mantle can affect core dynamics, and corresponding ways the core can affect the mantle. Self-contained volume starts with an overview of the subject then explores each topic with in depth detail Extensive reference lists and cross references with other volumes to facilitate further research Full-color figures and tables support the text and

aid in understanding Content suited for both the expert and non-expert
Dynamos is a collection of lectures given in July 2007 at the Les Houches Summer School on "Dynamos". Provides a pedagogical introduction to topics in Dynamos Addresses each topic from the basis to the most recent developments Covers the lectures by internationally-renowned and leading experts
Although the origin of Earth's and other celestial bodies' magnetic fields remains unknown, we do know that the motion of electrically conducting fluids generates and maintains these fields, forming the basis of magnetohydrodynamics (MHD) and, to a larger extent, dynamo theory. Answering the need for a comprehensive, interdisciplinary introduction to this area, Mathematical Aspects of Natural Dynamos provides a foundation in dynamo theory before moving on to modeling aspects of natural dynamos. Bringing together eminent international contributors, the book first introduces governing equations, outlines the kinematic dynamo theory, covers nonlinear effects, including amplitude saturation and polarity reversals, and discusses fluid dynamics. After establishing this base, the book describes the Earth's magnetic field and the current understanding of its characteristics. Subsequent chapters examine other planets in our solar system and the magnetic field of stars, including the sun. The book also addresses dynamo action on the large scale of galaxies, presents modeling experiments of natural dynamos, and speculates about future research directions. After reading this well-illustrated, thorough, and unified exploration, you will be well prepared

to embark on your own journey through this fascinating area of research.

"This book is the second volume of a compilation of lecture notes on various topics in nonlinear physics delivered by specialists during the summer schools organized by the Institut Non Linaeaire de Nice ... in Peyresq ... since 1998. The first volume, edited by R. Kaiser and J. Montaldi, contains courses from the years 1998 and 1999. This volume collects notes of the lectures given from the summers of 2000, 2001 and 2002"--Preface, v. 2.

This book contains the lectures given at the workshop "Dynamo and dynamics, a mathematical challenge" held in Cargese from August 21 to 26, 2000. The workshop differed from most previous conferences on the dynamo effect in two important respects. First, it was at this international conference that the experimental observation of homogeneous fluid dynamos was first reported. Second, the conference gathered scientists from very different fields, thus showing that thepynamo problem has become an interdisciplinary subject involving not only astrophysicists and geophysicists, but also scientists working in dynamical systems theory, hydrodynamics, and numerical simulation, as well as several groups in experimental physics. This book thus reports important results on various dynamo studies in these different contexts: - Decades after the discovery of the first analytic examples of laminar fluid dynamos, the self-generation of a magnetic field by a flow ofliquid sodium has been reported by the Karlsruhe and Riga groups. Although there were no doubts concerning the self generation by the

laminar Roberts-type or Ponomarenko-type flows that were used, these experiments have raised interesting questions about the influence of the turbulent fluctuations on the dynamo threshold and on the saturation level of the magnetic field.

The updated 2nd edition of this book presents a variety of image analysis applications, reviews their precise mathematics and shows how to discretize them. For the mathematical community, the book shows the contribution of mathematics to this domain, and highlights unsolved theoretical questions. For the computer vision community, it presents a clear, self-contained and global overview of the mathematics involved in image procesing problems. The second edition offers a review of progress in image processing applications covered by the PDE framework, and updates the existing material. The book also provides programming tools for creating simulations with minimal effort.

The Handbook of Mathematical Fluid Dynamics is a compendium of essays that provides a survey of the major topics in the subject. Each article traces developments, surveys the results of the past decade, discusses the current state of knowledge and presents major future directions and open problems. Extensive bibliographic material is provided. The book is intended to be useful both to experts in the field and to mathematicians and other scientists who wish to learn about or begin research in mathematical fluid dynamics. The Handbook illuminates an exciting subject that involves rigorous mathematical theory applied to an important physical problem, namely the motion of fluids.

In Part IV the stability of Ekman boundary layers, and boundary layer effects in magnetohydrodynamics and quasigeostrophic equations are discussed, and some open problems are presented."--BOOK JACKET.

The Explicit Body in Performance interrogates the avant-garde precedents and theoretical terrain that combined to produce feminist performance art. Among the many artists discussed are: * Carolle Schneemann * Annie Sprinkle * Karen Finley * Robbie McCauley * Ana Mendieta * Ann Magnuson * Sandra Bernhard * Spiderwoman Rebecca Schneider tackles topics ranging across the 'post-porn modernist movement', New Right censorship, commodity fetishism, perspectival vision, and primitivism. Employing diverse critical theories from Benjamin to Lacan to postcolonial and queer theory, Schneider analyses artistic and pop cultural depictions of the explicit body in late commodity capitalism. The Explicit Body in Performance is complemented by extensive photographic illustrations and artistic productions of postmodern feminist practitioners. The book is a fascinating exploration of how these artists have wrestled with the representational structures of desire.

This unified, interdisciplinary, and comprehensive collection provides a foundation in dynamo theory before moving on to modeling aspects of natural dynamos. It introduces governing equations, outlines the kinematic dynamo theory, covers nonlinear effects, and discusses fluid dynamics. The book then describes the Earth's magnetic field and the current understanding of its characteristics. Subsequent chapters examine other planets in our solar system and the magnetic field of stars, including the sun. The book also addresses dynamo action on the large scale of galaxies, presents modeling experiments of natural dynamos, and speculates about future research directions.

This book revises the evolution of ideas in various branches of magnetohydrodynamics (astrophysics, earth and solar dynamos, pinch, MHD turbulence and liquid metals) and reviews current trends and challenges. Uniquely, it contains the review articles on the development of

the subject by pioneers in the field as well as leading experts, not just in one, but in various branches of magnetohydrodynamics, such as liquid metals, astrophysics, dynamo and pinch. Scientists have made new inroads in the study of the Earth's deep interior. They have forged developments in this fascinating arena using experimental and observational techniques,. including seismology, monitoring of the Earth's rotation, geomagnetism, and accurate measurements of Earth's gravity fields. These techniques along with more theoretica

This book is intended for introductory courses in SIA within sociology, social policy, human geography and political science at postgraduate level. Specialist postgraduate and professional courses in policy- orientated social research and in social and general impact assessment.

This new edition of Mathematics for Dynamic Modeling updates a widely used and highly-respected textbook. The text is appropriate for upper-level undergraduate and graduate level courses in modeling, dynamical systems, differential equations, and linear multivariable systems offered in a variety of departments including mathematics, engineering, computer science, and economics. The text features many different realistic applications from a wide variety of disciplines. The book covers important tools such as linearization, feedback concepts, the use of Liapunov functions, and optimal control. This new edition is a valuable tool for understanding and teaching a rapidly growing field. Practitioners and researchers may also find this book of interest. Contains a new chapter on stability of dynamic models Covers many realistic applications from a wide variety of fields in an accessible manner Provides a broad introduction to the full scope of dynamical systems Incorporates new developments such as new models for chemical reactions and autocatalysis Integrates MATLAB throughout the

text in both examples and illustrations Includes a new introduction to nonlinear differential equations

The ability to understand and predict behavior in strategic situations, in which an individual's success in making choices depends on the choices of others, has been the domain of game theory since the 1950s. Developing the theories at the heart of game theory has resulted in 8 Nobel Prizes and insights that researchers in many fields continue to develop. In Volume 4, top scholars synthesize and analyze mainstream scholarship on games and economic behavior, providing an updated account of developments in game theory since the 2002 publication of Volume 3, which only covers work through the mid 1990s. Focuses on innovation in games and economic behavior Presents coherent summaries of subjects in game theory Makes details about game theory accessible to scholars in fields outside economics

Treatise on Geophysics, Second Edition, is a comprehensive and in-depth study of the physics of the Earth beyond what any geophysics text has provided previously. Thoroughly revised and updated, it provides fundamental and state-of-the-art discussion of all aspects of geophysics. A highlight of the second edition is a new volume on Near Surface Geophysics that discusses the role of geophysics in the exploitation and conservation of natural resources and the assessment of degradation of natural systems by pollution. Additional features include new material in the Planets and Moon, Mantle Dynamics, Core Dynamics, Crustal and Lithosphere Dynamics, Evolution of the Earth, and Geodesy volumes. New material is also presented on the uses of Earth gravity measurements. This title is essential for professionals, researchers, professors, and advanced undergraduate and graduate students in the fields of Geophysics and Earth system science. Comprehensive and detailed coverage of all aspects of geophysics

Fundamental and state-of-the-art discussions of all research topics Integration of topics into a coherent whole

Exploring the origins and evolution of magnetic fields in planets, stars and galaxies, this book gives a basic introduction to magnetohydrodynamics and surveys the observational data, with particular focus on geomagnetism and solar magnetism. Pioneering laboratory experiments that seek to replicate particular aspects of fluid dynamo action are also described. The authors provide a complete treatment of laminar dynamo theory, and of the mean-field electrodynamics that incorporates the effects of random waves and turbulence. Both dynamo theory and its counterpart, the theory of magnetic relaxation, are covered. Topological constraints associated with conservation of magnetic helicity are thoroughly explored and major challenges are addressed in areas such as fast-dynamo theory, accretion-disc dynamo theory and the theory of magnetostrophic turbulence. The book is aimed at graduate-level students in mathematics, physics, Earth sciences and astrophysics, and will be a valuable resource for researchers at all levels.

This twelfth volume in the Poincaré Seminar Series presents a complete and interdisciplinary perspective on the concept of Chaos, both in classical mechanics in its deterministic version, and in quantum mechanics. This book expounds some of the most wide ranging questions in science, from uncovering the fingerprints of classical chaotic dynamics in quantum systems, to predicting the fate of our own planetary system. Its seven articles are also highly pedagogical, as befits their origin in lectures to a broad scientific audience. Highlights include a complete description by the mathematician É. Ghys of the paradigmatic Lorenz attractor, and of the famed Lorenz butterfly effect as it is understood today, illuminating the fundamental

mathematical issues at play with deterministic chaos; a detailed account by the experimentalist S. Fauve of the masterpiece experiment, the von Kármán Sodium or VKS experiment, which established in 2007 the spontaneous generation of a magnetic field in a strongly turbulent flow, including its reversal, a model of Earth's magnetic field; a simple toy model by the theorist U. Smilansky – the discrete Laplacian on finite d-regular expander graphs – which allows one to grasp the essential ingredients of quantum chaos, including its fundamental link to random matrix theory; a review by the mathematical physicists P. Bourgade and J.P. Keating, which illuminates the fascinating connection between the distribution of zeros of the Riemann ?-function and the statistics of eigenvalues of random unitary matrices, which could ultimately provide a spectral interpretation for the zeros of the ?-function, thus a proof of the celebrated Riemann Hypothesis itself; an article by a pioneer of experimental quantum chaos, H-J. Stöckmann, who shows in detail how experiments on the propagation of microwaves in 2D or 3D chaotic cavities beautifully verify theoretical predictions; a thorough presentation by the mathematical physicist S. Nonnenmacher of the "anatomy" of the eigenmodes of quantized chaotic systems, namely of their macroscopic localization properties, as ruled by the Quantum Ergodic theorem, and of the deep mathematical challenge posed by their fluctuations at the microscopic scale; a review, both historical and scientific, by the astronomer J. Laskar on the stability, hence the fate, of the chaotic Solar planetary system we live in, a subject where he made groundbreaking contributions, including the probabilistic estimate of possible planetary collisions. This book should be of broad general interest to both physicists and mathematicians.

Astrophysical dynamos are at the heart of cosmic magnetic fields of a wide range of scales,

from planets and stars to entire galaxies. This book presents a thorough, step-by-step introduction to solar and stellar dynamos. Looking first at the ultimate origin of cosmic seed magnetic fields, the antagonists of field amplification are next considered: resistive decay, flux expulsion, and flows ruled out by anti-dynamo theorems. Two kinematic flows that can act as dynamos are then studied: the Roberts cell and the CP-flow. Mean-field electrodynamics and derivation of the mean-field dynamo equations lead to the alpha Omega-dynamo, the flux transport dynamo, and dynamos based on the Babcock-Leighton mechanism. Alternatives to the mean-field theory are also presented, as are global MHD dynamo simulations. Fluctuations and grand minima in the solar cycle are discussed in terms of dynamo modulations through stochastic forcing and nonlinear effects. The book concludes with an overview of the major challenges in understanding stellar magnetic fields and their evolution in terms of various dynamo models, global MHD simulations, and fossil fields. Each chapter is accompanied by an annotated bibliography, guiding the readers to the relevant technical literature, which may lead them to carry out their own research in the field of dynamo theory.

Dynamo and Dynamics, a Mathematical ChallengeSpringer Science & Business Media

The increasing power of computer resources along with great improvements in observational data in recent years have led to some remarkable and rapid advances in astrophysical fluid dynamics. The subject spans three distinct but overlapping communities whose interests focus on (1) accretion discs and high-energy astrophysics; (2) solar, stellar, and

This volume contains papers given at a workshop on the earth's core boundary and geodynamos held at Liblice Castle, Czechoslovakia in 1988.

This volume is based on lectures delivered at the 2011 AMS Short Course on Evolutionary

Game Dynamics, held January 4-5, 2011 in New Orleans, Louisiana. Evolutionary game theory studies basic types of social interactions in populations of players. It combines the strategic viewpoint of classical game theory (independent rational players trying to outguess each other) with population dynamics (successful strategies increase their frequencies). A substantial part of the appeal of evolutionary game theory comes from its highly diverse applications such as social dilemmas, the evolution of language, or mating behaviour in animals. Moreover, its methods are becoming increasingly popular in computer science, engineering, and control theory. They help to design and control multi-agent systems, often with a large number of agents (for instance, when routing drivers over highway networks or data packets over the Internet). While these fields have traditionally used a top down approach by directly controlling the behaviour of each agent in the system, attention has recently turned to an indirect approach allowing the agents to function independently while providing incentives that lead them to behave in the desired way. Instead of the traditional assumption of equilibrium behaviour, researchers opt increasingly for the evolutionary paradigm and consider the dynamics of behaviour in populations of agents employing simple, myopic decision rules.
The study of the magnetic fields of the Earth and Sun, as well as those of other planets, stars, and galaxies, has a long history and a rich and varied literature, including in recent years a number of review articles and books dedicated to the dynamo theories of these fields. Against this background of work, some explanation of the scope and purpose of the present monograph, and of the presentation and organization of the material, is therefore needed. Dynamo theory offers an explanation of natural magnetism as a phenomenon of magnetohydrodynamics (MHD), the dynamics governing the evolution and interaction of

motions of an electrically conducting fluid and electromagnetic fields. A natural starting point for a dynamo theory assumes the fluid motion to be a given vector field, without regard for the origin of the forces which drive it. The resulting kinematic dynamo theory is, in the non-relativistic case, a linear advection-diffusion problem for the magnetic field. This kinematic theory, while far simpler than its magnetohydrodynamic counterpart, remains a formidable analytical problem since the interesting solutions lack the easiest symmetries. Much ofthe research has focused on the simplest acceptable flows and especially on cases where the smoothing effect of diffusion can be exploited. A close analog is the advection and diffusion of a scalar field by laminar flows, the diffusion being measured by an appropriate Peclet number. This work has succeeded in establishing dynamo action as an attractive candidate for astrophysical magnetism.

The vigorous stirring of a cup of tea gives rise, as we all know, to interesting fluid dynamical phenomena, some of which are very hard to explain. In this book our "cup of tea" contains the currents of the Earth's atmosphere, oceans, mantle, and fluid core. Our goal is to under stand the basic physical processes which are most important in describing what we observe, directly or indirectly, in these complex systems. While in many respects our understanding is measured by the ability to predict, the focus here will be on relatively simple models which can aid our physical intuition by suggesting useful mathematical methods of investiga tion. These elementary models can be viewed as part of a hierarchy of models of increasing complexity, moving toward those which might be use fully predictive. The discussion in this book will deal primarily with the Earth. Interplanetary probes of Venus, Mars, Jupiter and Saturn have revealed many exciting phenomena which bear on geophysical fluid dynamics. They have also

enabled us to see the effect of changing the values of certain parameters, such as gravity and rotation rate, on geophysical flows. On the other hand, satellite observations of our own planet on a daily and hourly basis have turned it into a unique laboratory for the study of fluid motions on a scale never dreamt of before: the motion of cyclones can be observed via satellite just as wing tip vortices are studied in a wind tunnel.

This book is the second volume of lecture notes on various topics in nonlinear physics delivered by specialists in the field who gave courses in the small village of Peyresq (France) during summer schools (2000, 2001, 2002) organised by the Institut Non Linéaire de Nice (INLN), in collaboration with the Institut de Recherche de Physique Hors Equilibre (IRPHE). The goal is to provide good summaries on the state of the art of some domains in physics having the common denominator of belonging to nonlinear sciences, and to promote the transfer of knowledge between them.

A comprehensive view of our Sun at the start of a new era in solar and heliospheric physics Humans have been observing and studying our Sun for centuries, yet much is still unknown about the processes that drive its behavior. Thanks to a new generation of space missions and ground telescopes, we are poised to dramatically increase our understanding of the Sun and its environment. Solar Physics and Solar Wind explores advances in solar and heliospheric research over recent decades, as well as the challenges that remain. This comprehensive reference work covers the solar interior, magnetism and radiation, plasma heating and acceleration, the sun's atmosphere, and solar activity. Volume highlights include: Explanations for processes in the solar interior

New insights on the solar wind The challenges of measuring the Sun's magnetic field and its radiative output Description of solar atmospheric phenomena such as spicules and jets New developments in understanding flares and coronal mass ejections Ongoing research into how the solar corona is heated The American Geophysical Union promotes discovery in Earth and space science for the benefit of humanity. Its publications disseminate scientific knowledge and provide resources for researchers, students, and professionals. Find out more about the Space Physics and Aeronomy collection in this Q&A with the Editors in Chief

Treats the origin of magnetic fields in planets, stars and galaxies, and the manner of their evolution over time.

The increasing power of computer resources along with great improvements in observational data in recent years have led to some remarkable and rapid advances in astrophysical fluid dynamics. The subject spans three distinct but overlapping communities whose interests focus on (1) accretion discs and high-energy astrophysics; (2) solar, stellar, and galactic magnetic fields; and (3) the geodynamo, planetary magnetic fields, and associated experiments. This book grew out of a special conference sponsored by the London Mathematical Society with the support of EPSRC that brought together leading researchers in all of these areas to exchange ideas and review the status of the field. The many interesting problems addressed in this volume concern:

Very hot area with a wide range of applications; Gives complete numerical analysis and recipes, which will enable readers to quickly apply the techniques to real problems; Includes two new techniques pioneered by Osher and Fedkiw; Osher and Fedkiw are internationally well-known researchers in this area