Magnetohydrodynamics Of The Sun

VIRGINIA MCDOWELL

Mean-Field Magnetohydrodynamics and Dynamo Theory
Cambridge University Press
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Solar Flare Magnetohydrodynamics Cambridge University Press
A thorough introduction to solar physics based on recent spacecraft observations. The author introduces the solar corona and sets it in the context of basic plasma physics before moving on to discuss plasma instabilities and plasma heating processes. The latest results on coronal heating and radiation are presented. Spectacular phenomena such as solar flares and coronal mass ejections are described in detail, together with their potential effects on the Earth.
Principles of Magnetohydrodynamics Springer Science & Business Media
The Sun as a Guide to Stellar Physics illustrates the significance of the Sun in understanding stars through an examination of the discoveries and insights gained from solar physics research. Ranging from theories to modeling and from numerical simulations to instrumentation and data processing, the book provides an overview of what we currently understand and how the Sun can be a model for gaining further knowledge about stellar physics. Providing both updates on recent developments in solar physics and applications to stellar physics, this book strengthens the solar–stellar connection and summarizes what we know about the Sun for the stellar, space, and geophysics communities. Applies observations, theoretical understanding, modeling capabilities and physical processes first revealed by the sun to the study of stellar physics Illustrates how studies of Proxima Solaris have led to progress in space science, stellar physics and related fields Uses characteristics of solar phenomena as a guide for understanding the physics of stars
Interplanetary Magnetohydrodynamics
Magnetohydrodynamics of the Sun
Following on from the companion volume Principles of Magnetohydrodynamics, this textbook analyzes the applications of plasma physics to thermonuclear fusion and plasma astrophysics from the single viewpoint of MHD. This approach turns out to be ever more powerful when applied to streaming plasmas (the vast majority of visible matter in the Universe), toroidal plasmas (the most promising approach to fusion energy), and nonlinear dynamics (where it all comes together with modern computational techniques and extreme transonic and relativistic plasma flows). The textbook interweaves theory and explicit calculations of waves and instabilities of streaming plasmas in complex magnetic geometries. It is ideally suited to advanced undergraduate and graduate courses in plasma physics and astrophysics.
Physics of Space Storms Springer Science & Business Media
The book covers intimately all the topics necessary for the development of a robust magnetohydrodynamic (MHD) code within the framework of the cell-centered finite volume method (FVM) and its applications in space weather study. First, it presents a brief review of existing MHD models in studying solar corona and the heliosphere. Then it introduces the cell-centered FVM in three-dimensional computational domain. Finally, the book presents some applications of FVM to the MHD codes on spherical coordinates in various research fields of space weather, focusing on the development of the 3D Solar-InterPlanetary space-time Conservation Element and Solution Element (SIP-CESE) MHD model and its applications to space weather studies in various aspects. The book is written for senior undergraduates, graduate students, lecturers, engineers and researchers in solar-terrestrial physics, space weather theory, modeling, and prediction, computational fluid dynamics, and MHD simulations. It helps readers to fully understand and implement a robust and versatile MHD code based on the cell-centered FVM.
Smoothed Particle Magnetohydrodynamics for the Solar Corona Springer Science & Business Media
A time-dependent, nonplanar, two-dimensional (2-D) magnetohydrodynamic computer simulation model is used to simulate a series of solar flare-generated shock waves and their subsequent disturbances in interplanetary space between the sun and the earth's magnetosphere. The canonical or anzatz series of shock waves include initial velocities near the sun over the range 500 to 3000 km/sec. The ambient solar wind, through which the shocks propagate, is taken to be a steady-state flow that is independent of heliolongitude; its radial dependency consists of a representative set of plasma and magnetic field parameters which will be presented. Particular attention is directed to the MHD model's ability to address fundamental operational questions regarding the long-range forecasting of geomagnetic disturbances. These questions are: (1) will a disturbance (such as the present canonical series of solar flare shock waves) produce a magnetospheric and ionospheric disturbance, and, if so; (2) when wil it start; (3) how severe will it be; and (4) how long will it last? The model's output is used to compute various solar wind indices of current interest for this purpose. It is concluded that future work should be focused on a cohesive updating of, for example, daily measured solar parameters as input for the model whose output should be compared with spacecraft data for specific events.
Advanced Magnetohydrodynamics Springer Science & Business Media
Most of the solar system is in the plasma state and its subtle non-linear interaction with the magnetic field is described for many purposes by the equations of magnetohydrodynamics (MHD). Over the past few years this important and complex field has become one of the most actively pursued areas of research, with increasingly diverse applications in geophysics, space physics and astrophysics. This book examines the basic MHD topics, such as equilibria, waves, instabilities and reconnection and examines each in the context of different areas that utilize MHD. Many of the world's leading experts have contributed to this volume, which has been edited by two of the key enthusiasts. It is hoped that it can help the reader to appreciate and understand the common threads between the different branches of magnetohydrodynamics. This book will be a timely exposition of recent advances made in the field.
Solar and Astrophysical Magnetohydrodynamic Flows Cambridge University Press
Mean-Field Magnetohydrodynamics and Dynamo Theory provides a systematic introduction to mean-field magnetohydrodynamics and the dynamo theory, along with the results achieved. Topics covered include turbulence and large-scale structures; general properties of the turbulent electromotive force; homogeneity, isotropy, and mirror symmetry of turbulent fields; and turbulent electromotive force in the case of non-vanishing mean flow. The turbulent electromotive force in the case of rotational mean motion is also considered. This book is comprised of 17 chapters and opens with an overview of the general concept of mean-field magnetohydrodynamics, followed by a discussion on the back-reaction of the magnetic field on motion; the structure of the turbulent electromotive force; homogeneous and two-scale turbulence; turbulent electromotive force in the case of rotational mean motion; and the dynamo problem of magnetohydrodynamics. The dynamo theory, which is based on mean-field magnetohydrodynamics, is explained and its applications to cosmical objects are described. The remaining chapters explore toroidal and poloidal vector fields; a simple model of an α-effect dynamo; and spherical models of turbulent dynamos as suggested by cosmical bodies. This monograph will be of interest to physicists.
Magnetohydrodynamics of Plasma Relaxation World Scientific
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
Magnetohydrodynamics Elsevier
This book provides a self-contained introduction to magnetohydrodynamics (MHD), with emphasis on nonlinear processes. The book outlines the conventional aspects of MHD

theory, magnetostatic equilibrium and linear stability theory. It concentrates on nonlinear theory, starting with the evolution and saturation of individual ideal and resistive instabilities, continuing with a detailed analysis of magnetic reconnection and concluding with a study of the most complex nonlinear behavior, that of MHD turbulence. The last chapters describe three important applications of the theory: disruptive processes in tokomaks, MHD effects in the reversed field pinch, and solar flares.
Magnetohydrodynamics of the Sun Princeton University Press
Magnetohydrodynamics describes dynamics in electrically conductive fluids. These occur in our environment as well as in our atmosphere and magnetosphere, and play a role in the sun's interaction with our planet. In most cases these phenomena involve turbulences, and thus are very challenging to understand and calculate. A sound knowledge is needed to tackle these problems. This work gives the basic information on turbulence in nature, comtaining the needed equations, notions and numerical simulations. The current state of our knowledge and future implications of MHD turbulence are outlined systematically. It is indispensable for all scientists engaged in research of our atmosphere and in space science.
Turbulence in Magnetohydrodynamics Oxford University Press on Demand
Magnetohydrodynamics of the Sun is a completely new up-to-date rewrite from scratch of the 1982 book Solar Magnetohydrodynamics, taking account of enormous advances in understanding since that date. It describes the subtle and complex interaction between the Sun's plasma atmosphere and its magnetic field, which is responsible for many fascinating dynamic phenomena. Chapters cover the generation of the Sun's magnetic field by dynamo action, magnetoconvection and the nature of photospheric flux tubes such as sunspots, the heating of the outer atmosphere by waves or reconnection, the structure of prominences, the nature of eruptive instability and magnetic reconnection in solar flares and coronal mass ejections, and the acceleration of the solar wind by reconnection or wave-turbulence. It is essential reading for graduate students and researchers in solar physics and related fields of astronomy, plasma physics and fluid dynamics. Problem sets and other resources are available at www.cambridge.org/9780521854719.
Multiscale Coupling of Sun-Earth Processes Elsevier
I have felt the need for a book on the theory of solar magnetic fields for some time now. Most books about the Sun are written by observers or by theorists from other branches of solar physics, whereas those on magnetohydrodynamics do not deal extensively with solar applications. I had thought of waiting a few decades before attempting to put pen to paper, but one summer Josip Kleczek encouraged an im mediate start 'while your ideas are still fresh'. The book grew out of a postgraduate lecture course at St Andrews, and the resulting period of gestation or 'being with monograph' has lasted several years. The Sun is an amazing object, which has continued to reveal completely unexpected features when observed in greater detail or at new wavelengths. What riches would be in store for us if we could view other stars with as much precision! Stellar physics itself is benefiting greatly from solar discoveries, but, in tum, our understanding of many solar phenomena (such as sunspots, sunspot cycles, the corona and the solar wind) will undoubtedly increase in the future due to their observation under different conditions in other stars. In the 'old days' the solar atmosphere was regarded as a static, plane-parallel structure, heated by the dissipation of sound waves and with its upper layer expanding in a spherically symmetric manner as the solar wind. Outside of sunspots the magnetic field was thOUght to be unimportant with a weak uniform value of a few gauss.
The Sun as a Guide to Stellar Physics Cambridge University Press
Modern observations, including recent ones with the Hubble Space Telescope, have revealed that the Universe is replete with plasma outflows from all kinds of objects, ranging from stars in all their variety to galaxies. In this masterly survey of plasma astrophysics, written by leading practitioners, the first 15 articles in Part I deal with the use of the MHD approach in several key problems of solar plasma, such as magnetoconvection and magnetic field generation, sunspots and coronal loops, magnetic nonequilibrium and coronal heating, coronal mass ejections, the acceleration of the solar wind, and stellar winds across the Main Sequence. The following 16 articles of Part II deal with the use of the same MHD approach in several central and puzzling aspects of more distant astrophysical plasmas, such as the dynamics of the interstellar medium, collimated outflows from young stellar objects and accretion disks, molecular outflows and jets associated with enigmatic binaries and symbiotic stars, relativistic flows associated with superluminal microquasars in our own galaxy, astrophysical jets from nearby galaxies, or remote active galactic nuclei and quasars, probably fuelled by supermassive black holes. The emphasis throughout is on the striking underlying similarities in the physics of all these problems. Audience: Indispensable for solar physicists and astrophysics alike. An ideal textbook for graduate students in physics and astrophysics.
Dynamic Sun Springer Science & Business Media
This volume presents a full mathematical exposition of the growing field of coronal seismology which will prove invaluable for graduate students and researchers alike. Roberts' detailed and original research draws upon the principles of fluid mechanics and electromagnetism, as well as observations from the TRACE and SDO spacecraft and key results in solar wave theory. The unique challenges posed by the extreme conditions of the Sun's atmosphere, which often frustrate attempts to develop a comprehensive theory, are tackled with rigour and precision; complex models of sunspots, coronal loops and prominences are presented, based on a magnetohydrodynamic (MHD) view of the solar atmosphere, and making use of Faraday's concept of magnetic flux tubes to analyse oscillatory phenomena. The rapid rate of progress in coronal seismology makes this essential reading for those hoping to gain a deeper understanding of the field.
Effects of Mass Flow on Magnetohydrodynamic Phenomena in Solar Coronal Loops Cambridge University Press
Senior undergraduate and graduate textbook on key area in plasma physics and astrophysics.
Magnetohydrodynamic Modelling of Interplanetary Disturbances Between the Sun and Earth Springer Science & Business Media
The reconnection of magnetic fields is one of the most fascinating processes in plasma physics, responsible for phenomena such as solar flares and magnetospheric substorms. The concept of reconnection has developed through recent advances in exploring the magnetospheres of the Sun and Earth through theory, computer simulations and spacecraft observations. The great challenge in understanding it stems from balancing the large volumes of plasma and magnetic fields involved with the energy release with the physical mechanism which relies on the strongly localized behavior of charged particles. This book, edited by and with contributions from leading scientists in the field, provides a comprehensive overview of recent theoretical and observational findings concerning the physics of reconnection and the complex structures that may give rise to, or develop from, reconnection. It is intended for researchers and graduate students interested in the dynamics of plasmas.
Lectures on Magnetohydrodynamics and Cosmic Rays Cambridge University Press
This unique , authoritative book introduces and accurately depicts the current state-of-the art in the field of space storms. Professor Koskinen, renowned expert in the field, takes the basic understanding of the system, together with the pyhsics of space plasmas, and produces a treatment of space storms. He combines a solid base describing space physics phenomena with a rigourous theoretical basis. The topics range from the storms in the solar atmosphere through the solar wind, magnetosphere and ionosphere to the production of the storm-related geoelectric field on the ground. The most up-to-date information available ist presented in a clear, analytical and quantitative way. The book is divided into three parts. Part 1 is a phenomenological introduction to space weather from the Sun to the Earth. Part 2 comprehensively presents the fundamental concepts of space plasma physics. It consists of discussions of fundamental concepts of plasma physics, starting from underlying electrodynamics and statistical physics of charged particles and continuing to single particle motion in homogeneous electromagnetic fields, waves in cold plasma approximation, Vlasov theory, magnetohydrodynamics, instabilities in space plasmas, reconnection and dynamo. Part 3 bridges the gap between the fundamental plasma physics and research level physics of space storms. This part discusses radiation and scattering processes, transport and diffiusion, shocks and shock acceleration, storms on the Sun, in the magnetosphere, the coupling to the atmosphere and ground. The book is concluded wtih a brief review of what is known of space stroms on other planets. One tool for building this briege ist extensive cross-referencing between the various chapters. Exercise problems of varying difficulty are embedded within the main body of the text.
The Solar Tachocline Cambridge University Press
Magnetohydrodynamics of the SunCambridge University Press
Hydrodynamic and Magnetohydrodynamic Problems in the Sun and Stars Springer
This is the first book to give a comprehensive overview of recent observational and theoretical results on solar wind structures and fluctuations and magnetohydrodynamic waves and turbulence, preference being given to phenomena in the inner heliosphere. Emphasis is placed on the progress made in the past decade in the understanding of the nature and origin of especially small-scale, compressible and incompressible fluctuations. Turbulence models describing the spatial transport and spectral transfer of the fluctuations in the inner heliosphere are discussed. Intermittency of solar wind fluctuations and their statistical distributions are investigated. Studies of the heating and acceleration effects of the turbulence on the background wind are critically surveyed. Finally, open questions concerning the origin, nature and evolution of the fluctuations are listed, and perspectives for future research are outlined. The book is for graduate students and researchers in the field. Other target groups are scientists and professionals interested in space plasma physics and/or MHD turbulence.