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Magnetic Reconnection

Markus Aschwanden



Magnetic Reconnection:

Magnetic Reconnection Masaaki Yamada, 2022-04-19 The essential introduction to magnetic reconnection written by a leading pioneer of the field Plasmas comprise more than 99 percent of the visible universe and wherever plasmas are magnetic reconnection occurs In this common yet incompletely understood physical process oppositely directed magnetic fields in a plasma meet break and then reconnect converting the huge amounts of energy stored in magnetic fields into kinetic and thermal energy In Magnetic Reconnection Masaaki Yamada offers an illuminating synthesis of modern research and advances on this important topic Magnetic reconnection produces such phenomena as solar flares and the northern lights and occurs in nuclear fusion devices A better understanding of this crucial cosmic activity is essential to comprehending the universe and varied technological applications such as satellite communications Most of our knowledge of magnetic reconnection comes from theoretical and computational models and laboratory experiments but space missions launched in recent years have added up close observation and measurements to researchers tools Describing the fundamental physics of magnetic reconnection Yamada links the theory with the latest results from laboratory experiments and space based observations including the Magnetic Reconnection Experiment MRX and the Magnetospheric Multiscale MMS Mission He concludes by considering outstanding problems and laying out a road map for future research Aimed at advanced graduate students and researchers in plasma astrophysics solar physics and space physics Magnetic Reconnection provides cutting edge information on a vital area of scientific investigation

Magnetic Reconnection Walter Gonzalez, Eugene Parker, 2016-02-22 This book provides an overview of recent research highlights in the main areas of application of magnetic reconnection MR including planetary solar and magnetospheric physics and astrophysics It describes how research on magnetic reconnection especially concerning the Earth's magnetosphere has grown extensively due to dedicated observations from major satellite missions such as Cluster Double Star and Themis The accumulated observations from these missions are being supplemented by many theoretical and modelling efforts for which large scale computer facilities are successfully being used and the theoretical advances are also covered in detail Opening with an introductory discussion of some fundamental issues related to magnetic reconnection subsequent chapters address topics including collisionless magnetic reconnection MHD structures in 3D reconnection energy conversion processes fast reconnection mediated by plasmoids rapid reconnection and magnetic field topology Further chapters consider specific areas of application such as magnetospheric dayside and tail reconnection comparative reconnection in planetary systems and reconnection in astrophysical systems The book offers insight into discussions about fundamental concepts and key aspects of MR access to the full set of applications of MR as presently known in space physics and in astrophysics and an introduction to a new related area of study dealing with the annihilation of quantum magnetic fluxes and its implications in the study on neutron star activity The book is aimed primarily at students entering the field but will also serve as a useful reference text

for established scientists and senior researchers **Reconnection of Magnetic Fields** J. Birn, E. R. Priest, 2007-01-04 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 *Magnetic Reconnection* William Lewis, 2014-02-23 This volume covers different aspects of recent theoretical and observational work on magnetic reconnection a fundamental plasma physical process by which energy stored in magnetic field is converted often explosively into heat and kinetic energy This collection of papers from the fields of solar and space physics astrophysics and laboratory plasma physics is especially timely in view of NASA's upcoming Magnetospheric Multiscale mission which will use Earth's magnetosphere as a laboratory to test through in situ measurement of the plasma energetic particles and electric and magnetic fields the various and sometimes competing models and theories of magnetic reconnection This volume is aimed at researchers in solar physics magnetospheric physics and plasma physics Previously published in Space Science Reviews journal Vol 160 1 4 2011 *Magnetic Reconnection* William Lewis, 2011-12-31 This volume covers different aspects of recent theoretical and observational work on magnetic reconnection a fundamental plasma physical process by which energy stored in magnetic field is converted often explosively into heat and kinetic energy This collection of papers from the fields of solar and space physics astrophysics and laboratory plasma physics is especially timely in view of NASA's upcoming Magnetospheric Multiscale mission which will use Earth's magnetosphere as a laboratory to test through in situ measurement of the plasma energetic particles and electric and magnetic fields the various and sometimes competing models and theories of magnetic reconnection This volume is aimed at researchers in solar physics magnetospheric physics and plasma physics Previously published in Space Science Reviews journal Vol 160 1 4 2011 *Magnetic Reconnection* William Lewis, 2012-03-18 This volume covers different aspects of recent theoretical and observational work on magnetic reconnection a fundamental plasma physical process by which energy stored in magnetic field is converted often explosively into heat and kinetic energy This collection of papers from the fields of solar and space physics astrophysics and laboratory plasma physics is especially timely in view of NASA's upcoming Magnetospheric Multiscale mission which will use Earth's magnetosphere as a laboratory to test through in situ measurement of the plasma energetic particles and electric and magnetic fields the various and sometimes competing models and theories of magnetic reconnection This volume is aimed at

researchers in solar physics magnetospheric physics and plasma physics Previously published in Space Science Reviews journal Vol 160 1 4 2011 **Magnetic Reconnection in Space and Laboratory Plasmas** Edward W. Hones, 1984

Magnetic Reconnection in Plasmas D. Biskamp, 2000-09-14 This book first published in 2000 is a comprehensive introduction to this major topic in plasma physics for graduates and researchers Reconstruction of Magnetic Reconnection Events Thomas Penz, 2009 Magnetic reconnection is a basic process taking place in plasmas on Earth and in space After a general introduction this work focusses on magnetic reconnection in the Earth magnetosphere Because of the interaction between the solar wind and the terrestrial magnetic field magnetic field line merging is initiated under certain conditions leading to various phenomena like the polar aurora or the injection of high energetic particles influencing near Earth satellites The author presents a method to achieve detailed information about the reconnection process from remote satellite measurements Therefore an ill posed inverse problem is solved using regularization theory Using multi spacecraft measurements e.g. from the Cluster satellites it is possible to gain information about the spatial location of the reconnection event so this method presents a complementary approach to ground based and in situ satellite measurements The work combines a thorough analysis of theoretical space plasma problems with experimental data from satellite missions and numerical simulations to provide new insights in this exciting field of space physics **Space Weather Fundamentals**

George V. Khazanov, 2016-11-17 Space weather is one of the most significant natural hazards to human life and health Conditions of the sun and in the solar wind magnetosphere ionosphere and thermosphere can influence the performance and reliability of space borne and ground based technological systems If conditions in the space environment are adverse they can cause disruption of satellite operations communications navigation and electric power distribution grids leading to a variety of socioeconomic losses This book provides an overview of our current knowledge and theoretical understanding of space weather formation and covers all major topics of this phenomena from the sun to the Earth's ionosphere and thermosphere thus providing a fully updated review of this rapidly advancing field The book brings together an outstanding team of internationally recognised contributors to cover topics such as solar wind the Earth's magnetic field radiation belts the aurora spacecraft charging orbital drag and GPS **Plasma and Related Sciences: Experimental and Theoretical Approaches**

Mohamed Mokhtar Hefny, Paolo Francesco Ambrico, Amer El-Kalliny, Tarek A. Gad-Allah, Ashraf M. Tawfik, Hany Mohamed Hamouda, 2024-12-16 Plasma physics is one of the most important tools in explaining our Universe and it is extensively used in engineering industries and medicine to improve the standard of our living For example Cold atmospheric plasma CAP attracted great attention in the last years due to its ability to generate a cocktail of high densities of reactive oxygen species ROS reactive nitrogen species RNS UV and charged particles at room temperature This cocktail can be used in a wide range of applications such as water treatment surface treatment plasma medicine plasma agriculture materials synthesis nanotechnology and many other industrial applications CAP can be used directly through local treatment or

indirectly through plasma activated water or medium which opens the gates for many applications As a multidisciplinary field CAP intersects with various fields such as physics engineering chemistry biology biochemistry and many others The goal of this Research Topic entitled Plasma and related sciences experimental and theoretical approaches is to collect high quality research work related to CAP directly or indirectly through the related sciences such as the above mentioned ones The philosophy of this Research Topic is to bridge the gap between CAP and the related sciences together with providing the community of CAP with the most recent findings in the related sciences which opens the door for better understanding and hence the creation of more applications For example many breakthroughs have been achieved recently in fields such as chemistry materials science and nanotechnology and haven't been mentioned in combination with CAP yet

The Century of Space Science J.A. Bleeker, Johannes Geiss, M. Huber, 2012-12-06 One of the most attractive features of the young discipline of Space Science is that many of the original pioneers and key players involved are still available to describe their field Hence at this point in history we are in a unique position to gain first hand insight into the field and its development To this end The Century of Space Science a scholarly authoritative reference book presents a chapter by chapter retrospective of space science as studied in the 20th century The level is academic and focuses on key discoveries how these were arrived at their scientific consequences and how these discoveries advanced the thoughts of the key players involved With over 90 world class contributors such as James Van Allen Cornelis de Jager Eugene Parker Reimar Lüst and Ernst Stuhlinger and with a Foreword by Lodewijk Woltjer past ESO Director General this book will be immensely useful to readers in the fields of space science astronomy and the history of science Both academic institutions and researchers will find that this major reference work makes an invaluable addition to their collection

Encyclopedia of Astronomy & Astrophysics P Murdin, 2001-01-01 In a unique collaboration Nature Publishing Group and Institute of Physics Publishing have published the most extensive and comprehensive reference work in astronomy and astrophysics This unique resource covers the entire field of astronomy and astrophysics and this online version includes the full text of over 2 750 articles plus sophisticated search and retrieval functionality and links to the primary literature The Encyclopaedia's authority is assured by editorial and advisory boards drawn from the world's foremost astronomers and astrophysicists This first class resource is an essential source of information for undergraduates graduate students researchers and seasoned professionals as well as for committed amateurs librarians and lay people wishing to consult the definitive astronomy and astrophysics reference work

Particle Acceleration and Kinematics in Solar Flares Markus Aschwanden, 2013-03-09 Over the last decade we entered a new exploration phase of solar flare physics equipped with powerful spacecraft such as Yohkoh SoHO and TRACE that provide us detail rich and high resolution images of solar flares in soft X rays hard X rays and extreme ultraviolet wavelengths Moreover the large area and high sensitivity detectors on the Compton GRO spacecraft recorded an unprecedented number of high energy photons from solar flares that surpasses all detected high energy sources taken together from the rest of the universe

for which CGRO was mainly designed to explore. However, morphological descriptions of these beautiful pictures and statistical catalogs of these huge archives of solar data would not convey us much understanding of the underlying physics if we would not set out to quantify physical parameters from these data and would not subject these measurements to theoretical models. Historically, there has always been an unsatisfactory gap between traditional astronomy that dutifully describes the morphology of observations and the newer approach of astrophysics which starts with physical concepts from first principles and analyzes astronomical data with the goal to confirm or disprove theoretical models. In this review, we attempt to bridge this yawning gap and aim to present the recent developments in solar flare high energy physics from a physical point of view, structuring the observations and analysis results according to physical processes such as particle acceleration, propagation, energy loss, kinematics, and radiation signatures.

Space Physics and Aeronomy, Magnetospheres in the Solar System Romain Maggiolo, Nicolas André, Hiroshi Hasegawa, Daniel T. Welling, 2021-04-14
 Überblick über den aktuellen Wissensstand und künftige Forschungsrichtungen in der Magnetosphärenphysik. In den sechs Jahrzehnten seit der Einführung des Begriffs Magnetosphäre sind über den magnetisierten Raum der jeden Körper in unserem Sonnensystem umgibt viele Theorien entstanden und viele Erkenntnisse gewonnen worden. Jede Magnetosphäre ist einzigartig und verhält sich doch entsprechend den universellen physikalischen Vorgängen. Der Band *Magnetospheres in the Solar System* enthält Beiträge von Experten für Experimentalphysik, theoretische Physik und numerische Modellierung, die einen Überblick über verschiedene Magnetosphären vermitteln, von der winzigen Magnetosphäre des Merkur bis zu den gewaltigen planetarischen Magnetosphären von Jupiter und Saturn. Das Werk bietet insbesondere einen kompakten Überblick über die Geschichte der Magnetosphäre, ihre Grundzüge und Gleichungen, eine Zusammenfassung der grundlegenden Prozesse in der Magnetosphärenphysik, Instrumente und Techniken zur Untersuchung von Prozessen in der Magnetosphäre, eine besondere Schwerpunktsetzung auf die Magnetosphäre der Erde und ihre Dynamik, eine Darstellung der planetaren Magnetfelder und Magnetosphären im gesamten Sonnensystem, eine Definition der künftigen Forschungsrichtungen in der Magnetosphärenphysik. Die Amerikanische Geophysikalische Vereinigung fördert die wissenschaftliche Erforschung der Erde und des Weltraums zum Wohle der Menschheit. In ihren Publikationen werden wissenschaftliche Erkenntnisse veröffentlicht, die Forschern, Studenten und Fachkräften zur Verfügung stehen.

Physics of the Solar Corona Markus Aschwanden, 2006-01-30
 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.

Frontiers in Magnetospheric Plasma Physics, 2004-12-14
 This COSPAR Colloquium Series deals with the main achievements that were accomplished through the collaborative efforts among ISTP participants: the plasma dynamics of

magnetic reconnection in a thin plasma sheet the action of the solar wind on the plasma population in the plasma sheet and around the magnetotail boundary layer the relationship between the substorm expansion region and the X line formation in the magnetotail and the temporal evolution of the dipolarization from the near Earth to the distant tail **Advances in Space Environment Research** I.H. Cairns,S.B. Gabriel,J.P. Goedbloed,T. Hada,M. Leubner,L. Nocera,R. Stening,F. Toffoletto,C. Uberoi,J.A. Valdivia,U. Villante,C.-C. Wu,Y. Yan,2012-12-06 Advances in Space Environment Research Volume I contains the proceedings of two international workshops the World Space Environment Forum WSEF2002 and the High Performance Computing in Space Environment Research HPC2002 organized by the World Institute for Space Environment Research WISER from 22 July to 2 August 2002 in Adelaide Australia The articles in this volume review the state of the art of the theoretical computational and observational studies of the physical processes of Sun Earth connections and Space Environment They cover six topical areas Sun Heliosphere Magnetosphere Bow Shock Ionosphere Atmosphere Space Weather Space Climate Space Plasma Physics Astrophysics and Complex Intelligent Systems **Dayside Magnetosphere Interactions** Qiugang Zong,Philippe Escoubet,David Sibeck,Guan Le,Hui Zhang,2020-03-13 Exploring the processes and phenomena of Earth s dayside magnetosphere Energy and momentum transfer initially taking place at the dayside magnetopause is responsible for a variety of phenomenon that we can measure on the ground Data obtained from observations of Earth s dayside magnetosphere increases our knowledge of the processes by which solar wind mass momentum and energy enter the magnetosphere Dayside Magnetosphere Interactions outlines the physics and processes of dayside magnetospheric phenomena the role of solar wind in generating ultra low frequency waves and solar wind magnetosphere ionosphere coupling Volume highlights include Phenomena across different temporal and spatial scales Discussions on dayside aurora plume dynamics and related dayside reconnection Results from spacecraft observations ground based observations and simulations Discoveries from the Magnetospheric Multiscale Mission and Van Allen Probes era Exploration of foreshock bow shock magnetosheath magnetopause and cusps Examination of similar processes occurring around other planets 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 this book from this Q A with the editors *Microphysics of Cosmic Plasmas* André Balogh,Andrei Bykov,Peter Cargill,Richard Dendy,Thierry Dudok de Wit,John Raymond,2014-01-15 Presents a comprehensive review of physical processes in astrophysical plasmas This title presents a review of the detailed aspects of the physical processes that underlie the observed properties structures and dynamics of cosmic plasmas An assessment of the status of understanding of microscale processes in all astrophysical collisionless plasmas is provided The topics discussed include turbulence in astrophysical and solar system plasmas as a phenomenological description of their dynamic properties on all scales observational theoretical and modelling aspects of collisionless magnetic reconnection the formation and dynamics of shock

waves and a review and assessment of microprocesses such as the hierarchy of plasma instabilities non local and non diffusive transport processes and ionisation and radiation processes In addition some of the lessons that have been learned from the extensive existing knowledge of laboratory plasmas as applied to astrophysical problems are also covered This volume is aimed at graduate students and researchers active in the areas of cosmic plasmas and space science Originally published in Space Science Reviews journal Vol 278 2 4 2013

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