

Physics Of The Aurora And Airglow International

Science, biography, and arctic exploration coverage in this extraordinary true story of the life and work of Norwegian scientist Kristian Birkeland, the troubled genius who solved the mysteries of one of nature's most spectacular displays. Captivated by the otherworldly lights of the aurora borealis, Birkeland embarked on a lifelong quest to discover their cause. His pursuit took him to some of the most forbidding landscapes on earth, from the remote snowcapped mountains of Norway to the war-torn deserts of Africa. In the face of rebuke by the scientific establishment, sabotage by a jealous rival, and his own battles with depression and paranoia, Birkeland remained steadfast. Although ultimately vindicated, his theories were unheralded—and his hopes for the Nobel Prize scuttled—at the time of his suspicious death in 1917. The Northern Lights offers a brilliant account of the physics behind the aurora borealis and a rare look inside the mind of one of history's most visionary scientists.

Authoritative account written for the general reader.

Video clip of a NASA film highlights the time delay in communication between Apollo astronauts and Houston.

The aim of this book is to describe and discuss the aurora as an optical phenomenon, one which can be observed by the naked eye as well as with more sensitive optical detectors. It continues the tradition of studying that impressive and imaginative play of nature, the northern lights, seen and discussed by the Greek philosophers as early as the sixth century B.c. Today the study of the optical aurora is only one of many ways of acquiring information about a major phenomenon: the ejection of plasma from the sun, the interaction of this plasma with the geomagnetic field and the injection of fast particles into the earth's atmosphere. Hence, the separate treatment of the optical aurora is justified by the scientific approach: detection and interpretation of electromagnetic radiation, approximately in the 1000-100000 Å region, produced through interaction between the auroral particles and the earth's atmosphere. Other techniques, such as radio observations, X-ray observations, direct particle detections from rockets and satellites, studies of magnetic storms, and measurements of the magnetic field and plasma properties in the magnetosphere, are as important or more important than the classical way of studying the optical aurora. Nevertheless, it was felt worthwhile to treat the optical aurora in a separate book, perhaps mainly because today one author cannot master the whole subject with sufficient competence. This book is thus one volume in a series of books giving a more complete picture of physics and chemistry in space.

Published by the American Geophysical Union as part of the Geophysical Monograph Series, Volume 197. Many of the most basic aspects of the aurora remain unexplained. While in the past terrestrial and planetary auroras have been

largely treated in separate books, *Auroral Phenomenology and Magnetospheric Processes: Earth and Other Planets* takes a holistic approach, treating the aurora as a fundamental process and discussing the phenomenology, physics, and relationship with the respective planetary magnetospheres in one volume. While there are some behaviors common in auroras of the different planets, there are also striking differences that test our basic understanding of auroral processes. The objective, upon which this monograph is focused, is to connect our knowledge of auroral morphology to the physical processes in the magnetosphere that power and structure discrete and diffuse auroras. Understanding this connection will result in a more complete explanation of the aurora and also further the goal of being able to interpret the global auroral distributions as a dynamic map of the magnetosphere. The volume synthesizes five major areas: auroral phenomenology, aurora and ionospheric electrodynamics, discrete auroral acceleration, aurora and magnetospheric dynamics, and comparative planetary aurora. Covering the recent advances in observations, simulation, and theory, this book will serve a broad community of scientists, including graduate students, studying auroras at Mars, Earth, Saturn, and Jupiter. Projected beyond our solar system, it may also be of interest for astronomers who are looking for aurora-active exoplanets.

A multitude of processes that operate in the upper atmosphere are revealed by detailed physical and mathematical descriptions of the interactions of particles and radiation, temperatures, spectroscopy and dynamics.

A celebration of nature's spectacular lightshows, and a visual feast documenting the kaleidoscopic colors that decorate the sky. For millennia, humans have been fascinated with the ghostly green and red curtains of light that shimmer across the heavens on dark, clear nights. Ancient peoples saw these displays as souls of the dead, the torches of the spirits and as harbingers of war. Barely 100 years ago, scientists finally learned that an aurora is created when the Earth's magnetic field is bombarded with charged particles from the sun. When the charged particles collide with oxygen in the atmosphere, auroras with yellows, greens and reds appear. Collisions with nitrogen result in bluish colors. However, our understanding of the physics behind auroras has not detracted from their wonder. *Auroras* is filled with 80 photographs of one of nature's greatest spectacles, complete with captions that reflect on the folklore, science and beauty of the northern lights. The book poses and answers the many scientific questions about auroras: Why are auroras usually seen only at high latitudes? How do scientists study them? What causes the different colors? Why are massive auroras often followed by blackouts and computer system crashes? *Auroras* is where cutting-edge science meets the stuff of dreams.

The beautiful aurorae, or northern lights, are the stuff of legends. The ancient stories of the Sami people warn that if you mock the lights they will seize you, and their mythical appeal continues to capture the hearts and imagination of people across the globe.

Welcome to a brand-new way of thinking about branding. The Physics of Brand is an exploration of how brands evolve in time and space. Drawing on experience working with companies such as Patagonia, General Mills, Target, and more, this book provides an exciting new systems approach to branding. By focusing on how brands and people actually interrelate, you'll gain a new perspective on brand growth and interaction. Complete with case studies to illustrate these concepts and Thought Experiments to get you thinking conceptually, The Physics of Brand is your new textbook on brand theory.

This volume surveys our current scientific understanding of the terrestrial aurora. It is organized into eleven reviews detailing theoretical and observational aspects of characteristic auroral morphologies, and how these in turn are organized according to local time, latitude, and activity level. Popular descriptions often attribute the aurora to the interaction of charged particles from the solar wind with atoms in the upper atmosphere. In fact, most auroras are not the result of direct entry of solar wind particles. Rather, as detailed in this volume, auroral particle acceleration and generation of auroral forms occur primarily within the magnetosphere. Importantly, many key aspects of the aurora – most notably, the physical mechanisms responsible for the generation of discrete arcs – are still unexplained, and auroral physics continues to be an active area of scientific research. Each review chapter therefore includes a summary of open questions for further investigation. Providing the first comprehensive review of the terrestrial aurora in two decades, this book will aid both active researchers and newcomers interested in understanding the current state of the field. Previously published Space Science Reviews in the Topical Collection "Auroral Physics"

This book describes the history of the progress made in auroral science and magnetospheric physics by providing examples of ideas, controversies, struggles, acceptance, and success in some instances. The author, a distinguished auroral scientist, fully describes his experiences in characterizing and explaining auroral phenomena. The volume also includes beautiful full-color photos of the aurora.

This text provides a comprehensive introduction to space physics.

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.

Perspectives in Computation covers three broad topics: the computation process & its limitations; the search for computational efficiency; & the role of quantum mechanics in computation.

Over the past two decades auroral science has developed from a somewhat mysterious and imprecise specialty into a discipline central in the study of the ionosphere and magnetosphere. The investigation of aurora unites scientists with very different backgrounds and interests so that it is difficult to write a self-contained account of the field in a book of reasonable length. In this work I have attempted to include those aspects of theory which I have found valuable in predicting the effects on the atmosphere of auroral particle precipitation. In addition I have attempted to describe the techniques of observation with particular emphasis on optical methods which have been useful. While the aeronomy of aurora has been regarded as central, the mechanisms by which particles are accelerated and precipitated into the atmosphere is of no less interest. This aspect of the subject has however been treated in a briefer fashion since it is a part of the immense and rapidly developing field of magnetospheric science. Generally I have attempted to provide a coherent introduction to auroral science with an emphasis on relatively simple physical interpretations and models. References are given to enable the reader to find more extensive or rigorous discussions of particular topics. A fairly complete, quantitative atlas of the auroral spectrum is included.

International Geophysics Series, Volume 2: Physics of the Aurora and Airglow explores certain physical aspects of aurora and airglow. This volume is composed of 13 chapters and begins with surveys of the theory and spectroscopic and photometric analyses of radiation from the upper atmosphere. The subsequent chapters treat the geographic distribution of aurora and its physical processes in the atmosphere. Other chapters examine the theory of hydrogen emission in aurora, resonance scattering by atmospheric sodium, the excitation of the oxygen red lines in the airglow, and an atlas of the auroral spectrum. A chapter focuses on the analysis of twilight observations for emission heights. The concluding chapters discuss the theory of day airglow, as well as the spectral photometry and excitation of the nightglow. This book is of value to geophysicists, theoreticians, and scientists of the allied fields of geophysics.

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.

Explores how the management of wetlands can influence carbon storage and fluxes Wetlands are vital natural assets, including their ability to take-up atmospheric carbon and restrict subsequent carbon loss to facilitate long-term storage. They can be deliberately managed to provide a natural solution to mitigate climate change, as well as to help offset direct losses of wetlands from various land-use changes and natural drivers. Wetland Carbon and Environmental Management presents a collection of wetland research studies from around the world to demonstrate how environmental management can improve carbon sequestration while enhancing wetland health and function. Volume highlights include: Overview of carbon storage in the landscape Introduction to wetland management practices Comparisons of natural, managed, and converted wetlands Impact of wetland management on carbon storage or loss Techniques for scientific assessment of wetland carbon processes Case studies covering tropical, coastal, inland, and northern wetlands Primer for carbon offset trading programs and how wetlands might contribute 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.

Auroral physics is a subject that has seen considerable change and development over the past twenty years, particularly because of its importance to space research and the exploration of the near earth environment. In July 1988, a conference held at St. Johns College, Cambridge, celebrated the centenary of Sydney Chapman, the founder of the subject in its modern form, and brought together an international group of experts in the field to discuss important developments and the likely directions of future research. Auroral Physics gives a comprehensive overview of the subject, and puts forward some important new ideas.

Man, through intensive observations of natural phenomena, has learned about some of the basic principles which govern nature. The aurora is one of the most fascinating of these natural phenomena, and by studying it, man has just begun to comprehend auroral phenomena in terms of basic cosmic electrodynamic processes. The systematic and extensive observation of the aurora during and after the great international enterprise, the International Geophysical Year (IGY), led to the concept of the auroral substorm. Like many other geophysical phenomena, auroral displays have a dual time (universal- and local-time) dependence when seen by a ground-based observer. Thus, it was a difficult task for single observers, rotating with the Earth once a day, to grasp a transient feature of a large-scale auroral display. Such a complexity is inevitable in studying many geophysical features, in particular the polar upper atmospheric phenomena. However, it was found that their complexity began to unfold when the concept of the auroral substorm was introduced. In a book entitled Polar and Magnetospheric Substorms, the predecessor to this book, I tried to describe the auroral phenomena as completely as possible in terms of the concept of the auroral substorm. At that time, the first satellite observations of particles and magnetic fields during substorms were just becoming available, and it was suggested that the auroral sub storm is a manifestation of a magnetospheric phenomenon called the magnetospheric substorm. The aurora is the most visible manifestation of the connection of the Earth to the space environment and has inspired awe, curiosity, and scientific inquiry for centuries. Recent advances in observing techniques and modeling and theoretical work have

revealed new auroral phenomena, provided a better understanding of auroral dynamics, and have led to an enhanced capability for auroral forecasts. This monograph features discussions of: New auroral phenomena due to the ring current ion and polar rain electron precipitation Various auroral forms and hemispheric asymmetry Auroral model development and MHD simulations Application of the auroral observations for radio absorption and scintillation Aurora nowcast and forecast for space weather operations Auroral Dynamics and Space Weather is a valuable contribution for scientists, researchers, space weather operators, and students of Earth's space environment.

The beautiful aurorae, or northern lights, are the stuff of legends. The ancient stories of the Sami people warn that if you mock the lights they will seize you, and their mythical appeal continues to capture the hearts and imagination of people across the globe. Aurora explores the visual beauty, ancient myths and science of the northern lights and challenges the popular theory of how the lights are formed. Plasma physicist Melanie Windridge explains this extraordinary and evocative phenomenon, a scientific marvel unlike any other in which the powers of astronomy, geology, magnetism and atomic physics combine to create one of the wonders of the natural world. As Melanie travels in search of the perfect aurora, she uncovers the scientific realities of this plasmic phenomenon full of natural power. She combines the science behind the lights with a fascinating travelogue as she pursues the aurora across the northern hemisphere - from the Arctic Circle to Scotland.

How did electrons in the high atmosphere and space around the Earth come to acquire their speeds and energies? This intriguing question lies at the heart of understanding how high-energy electrons create the spectacular displays of the ^A Aurora Borealis and ^A Aurora Australis. Electron Acceleration in the Aurora and Beyond explores the mysteries of these phenomena and others involving the acceleration of electrons in the magnetosphere, in the solar wind, at the Sun and in the Cosmos. This book presents a new approach to understanding this fascinating subject by treating the acceleration medium as a plasma. Using this new insight we can see that electron acceleration may well be caused by waves rather than steady potential differences. This unique approach is clearly explained in a lively and engaging style. Quantitative formulae, experiments, practical demonstrations and computer programs enable us to investigate for ourselves how the model works. The theory is further illustrated by comparing acceleration in space with particle accelerators in the nuclear physics laboratory (and even on the sports field!) Questions and exercises with answers are supplied to stimulate further thinking. ^A Electron Acceleration in the Aurora and Beyond is a thought-provoking book for graduate and post-doctoral space scientists.

Electric green pierced by neon blue, shocking pink spinning into violent red, and shimmering purple sidled up against deep indigo: never before have you seen such high-octane colors in the sky, and never before has a book shown the northern lights-aurora borealis-in such vivid color. In Northern Lights, photographers Calvin Hall and Daryl Pederson bring to print nearly a hundred photographs of this amazing natural phenomenon, shot from remote locations all over Alaska and using no filters or digital enhancement. Just as fascinating are the legends, myths, and science surrounding this polar phenomenon, described by George Bryson. As 2002 marks the peak viewing time of the northern lights in an eleven-year cycle, this book brings the elusive magic of

