Physics And Chemistry Of Comets

The 1985/86 apparition of Halley's Comet turned out to be the most important apparition of a comet ever. It provided a worldwide science community with a wealth of exciting new discoveries, the most remarkable of which was undoubtedly the first image of a cometary nucleus. Halley's Comet is the brightest periodic comet, and the most famous of the 750 known comets. With its 76-year period, its recent appearance was truly a "once-in-a-lifetime" observational opportunity. The 1985/86 apparition was the thirtieth consecutive recorded apparition. Five apparitions ago, the English astronomer Edmond Halley discovered the periodicity of "his" comet and correctly predicted its return in 1758, a triumph for science best appreciated in the context of contemporary views, or rather fears, about comets at that time. The increasingly rapid progress in technological development is very much apparent when one compares the dominant tools for cometary research during Halley's next three apparitions: in 1835 studies were made based on drawings ofthe comet; in 1910 photographic plates were used; while in March 1986 an armada of six spacecraft from four space agencies approached the comet and carried out in situ measurements, 1 AU from the Earth. In 1910, nobody could have dreamed that this was possible, and today it is equally difficult to anticipate what scientists will be able to achieve in 2061.

The second edition of Solar System Astrophysics: Planetary Atmospheres and the Outer Solar System provides a timely update of our knowledge of planetary atmospheres and of the bodies of the outer solar system and their analogs in other planetary systems. This volume begins with an expanded treatment of the physics, chemistry, and meteorology of the atmospheres of the Earth, Venus, and Mars, moving on to their magnetospheres and then to a full discussion of the gas and ice giants and their properties. From here, attention switches to the small bodies of the solar system, beginning with the natural satellites. The comets, meteors, meteorites, and asteroids are discussed in order, and the volume concludes with the origin and evolution of our solar system. Finally, a fully revised section on extrasolar planetary systems puts the development of our system in a wider and increasingly well understood galactic context. All of the material is presented within a framework of historical importance. This book and its sister volume, Solar System Astrophysics: Background Science and the Inner Solar system, are pedagogically well written, providing clearly illustrated explanations, for example, of such topics as the numerical integration of the Adams-Williamson equation, the equations of state in planetary interiors and atmospheres, Maxwell’s equations as applied to planetary ionospheres and magnetospheres, and the physics and chemistry of the Habitable Zone in planetary systems. Together, the volumes form a comprehensive text for any university course that aims to deal with all aspects of solar and extra-solar planetary systems. They will appeal separately to the intellectually curious who would like to know how just how far our knowledge of the solar system has progressed in recent years.

Planetary Sciences presents a comprehensive coverage of this fascinating and expanding field at a level appropriate for graduate students and researchers in the physical sciences. The book explains the wide variety of physical, chemical and geological processes that govern the motions and properties of planets. Observations of the planets, moons, asteroids, comets and planetary rings in our Solar System, as well as extrasolar planets, are described, and the process of planetary formation is discussed.

Meteor Showers and their Parent Comets is a unique handbook for astronomers interested in observing meteor storms and outbursts. Spectacular displays of 'shooting stars' are created when the Earth's orbit crosses a meteoroid stream, as each meteoroid causes a bright light when it enters our atmosphere at high speed. Jenniskens, an active meteor storm chaser, explains how meteoroid streams originate from the decay of meteoroids, comets and asteroids, and how they cause meteor showers on Earth. He includes the findings of recent space missions to comets and asteroids, the risk of meteor impacts on Earth, and how meteor showers may have seeded the Earth with ingredients that made life possible. All known meteor showers are identified, accompanied by fascinating details on the most important showers and their parent comets. The book predicts when exceptional meteor showers will occur over the next fifty years, making it a valuable resource for both amateur and professional astronomers.

Long before Galileo published his discoveries about Jupiter, lunar craters, and the Milky Way in the Starry Messenger in 1610, people were fascinated with the planets and stars around them. That interest continues today, and scientists are making new discoveries at an astounding rate. Ancient lake beds on Mars, robotic spacecraft missions, and new definitions of planets now dominate the news. How can you take it all in? Start with the new Encyclopedia of the Solar System, Second Edition. This self-contained reference follows the trail blazed by the bestselling first edition. It provides a framework for understanding the origin and evolution of the solar system, historical discoveries, and details about planetary bodies and how they interact—and has jumped light years ahead in terms of new information and visual impact. Offering more than 50% new material, the Encyclopedia includes the latest explorations and observations, hundreds of new color digital images and illustrations, and more than 1,000 pages. It stands alone as the definitive work in this field, and will serve as a modern messenger of scientific discovery and provide a look into the future of our solar system. · Forty-seven chapters from 75+ eminent authors review fundamental topics as well as new models, theories, and discussions · Each entry is detailed and scientifically rigorous, yet accessible to undergraduate students and amateur astronomers · More than 700 full-color digital images and diagrams from current space missions and observatories amplify the chapters · Thematic chapters provide up-to-date coverage, including a discussion on the new International Astronomical Union (IAU) vote on the definition of a planet · Information is easily accessible with numerous cross-references and a full glossary and index

Comets are small bodies, but of great cosmic relevance. Given its pristine nature, they may preserve valuable and unique information on thechemical and physical processes that took place in theearly solar system, and that may be occurring in the formation of other planetary systems. They might have even played a very important role in the origin of life on Earth. Beyond that, since ancient times comets have inspired awe, superstition, and also curiosity anddebate. Their sudden apparitions challenged the long-held view of the immutability of the heavens, which triggered a long debate on whether comets had a heavenly or terrestrial nature. Therefore, comets have a prominent role in the history of scienti?cthought, that goes back to the most ancient civilizations. The last apparition of comet Halley in 1986 was a landmark since it arouse a great expectation in the scienti?c community and in the public at large. For the ?rst time, a ?otilla of spacecrafts visited a comet. Agreat number of popular and technical books were written on Halley, and comets in general, around the mid-eighties. The interest in comets never subsided after Halley’s passage which is re?ected in the large volume of printed material on these bodies. I have taken the challenge to write a new book on comets that summarizes most of the recent

advances on thesubject, including my own workdeveloped during the last 25 years.
The return of Halley's Cornet in 1986 has generated much ex citement in the scientific community with preparations already afoot for an International Cornet Watch and a cornet launch by the European Space Community, the Japanese and Soviet Space Scientists. The meet ing held at the University of Maryland in October 1980 was primarily stimulated by the preparations for further study of this cornet and by one of the most important unanswered questions related to comets, name ly, whether they may have made a eontribution to the origin of life on earth. Our un"derstanding of the role of comets in the origin of life must necessarily come from our studies of the astronomy and the chem istry of comets. Some clues to the processes which led to the for mation of organic molecules and eventually to the appearance of life have come from these studies of comets, perhaps the most ancient of all objects in our solar system. Whether there is, however, a biology of comets still remains to be seen, although some claims have been made that perhaps comets might themselves provide an environment for even the beginnings of life. Scientists with the latest available information on comets and differing opinions as to the role of comets in the origin of life attended this symposium. The formal papers presented are now being made available to the students of chemical evolution within the pages of this volume.
Volume 1 provides a broad overview of the chemistry of the solar system. It includes chapters on the origin of the elements and solar system abundances, the solar nebula and planet formation, meteorite classification, the major types of meteorites, important processes in early solar system history, geochemistry of the terrestrial planets, the giant planets and their satellite, comets, and the formation and early differentiation of the Earth. This volume is intended to be the first reference work one would consult to learn about the chemistry of the solar system. Reprinted individual volume from the acclaimed Treatise on Geochemistry (10 Volume Set, ISBN 0-08-043751-6, published in 2003)
Interstellar dust, meteorites, interplanetary dust particles (IDP's), the zodiacal light, comets, comet dust. Where do they come from, what are they made of, how do they evolve, and finally, are there connections between them? These are the questions discussed in this volume by some of the world's outstanding experts in their respective fields. The techniques used for studying the `small' solid objects of space are thoroughly discussed. Some of the methods involve a synthetic approach using the laboratory to create analog environments and materials which are believed to resemble those in space. Others use direct laboratory methods with state-of-the-art analytical tools to study the material of the objects themselves - meteorites, IDP'S. And others apply the latest in astronomical facilities to provide quantitative data on the material properties of the solids which can only be deduced from remote observations, These are compared with the laboratory results. In one instance there was a possibility to study a solar system body in situ and that was the case of comet Halley and some of the results of these studies obtained from space `laboratories' launched to meet it are discussed here. Finally, there are theoretical papers which are aimed at bridging the results of observational and laboratory methods. This book is recommended to senior scientists as well as graduate students who wish to pursue research in interstellar and solar system astronomy and their connections.
Physics and Chemistry of the Solar System, 2nd Edition, is a comprehensive survey of the planetary physics and physical chemistry of our own solar system. It covers current research in these areas and the planetary sciences that have benefited from both earth-based and spacecraft-based experimentation. These experiments form the basis of this encyclopedic reference, which skillfully fuses synthesis and explanation. Detailed chapters review each of the major planetary bodies as well as asteroids, comets, and other small orbitals. Astronomers, physicists, and planetary scientists can use this state-of-the-art book for both research and teaching. This Second Edition features extensive new material, including expanded treatment of new meteorite classes, spacecraft findings from Mars Pathfinder through Mars Odyssey 2001, recent reflections on brown dwarfs, and descriptions of planned NASA, ESA, and Japanese planetary missions. * New edition features expanded treatment of new meteorite classes, the latest spacecraft findings from Mars, information about 100+ new discoveries of planets and stars, planned lunar and planetary missions, more end-of-chapter exercises, and more * Includes extensive new material and is amply illustrated throughout * Reviews each major planetary body, asteroids, comets, and other small orbitals
Comets have inspired wonder, excitement and even fear ever since they were first observed. But they are important members of the solar system, that contain material from early in the life of the system, held in deep-freeze. This makes them key in our understanding of the formation and evolution of many Solar System bodies. Recent ground- and space-based observations have changed much in our understanding of comets. Comets, and How to Observe Them gives a summary of our current knowledge and describes how amateur astronomers can contribute to the body of scientific knowledge of comets. This book contains many practical examples of how to construct comet light-curves, measure how fast a comet’s coma expands, and determine the rotation period of the nucleus. All these examples are illustrated with drawings and photographs. Because of their unpredictable nature comets are always interesting and sometime spectacular objects to observe and image. The second part of the book therefore takes the reader through the key observing techniques that can be used with commercially available modern observing equipment, from basic observations to more scientific measurements.
Although the development of ideas about the motion and trajectory of comets has been investigated piecemeal, we lack a comprehensive and detailed survey of ph- ical theories of comets. The available works either illustrate relatively short periods in the history of physical cometology or portray a landscape view without adequate details. The present study is an attempt to review – with more details – the major physical theories of comets in the past two millennia, from Aristotle to Whipple. My research, however, did not begin with antiquity. The basic question from which this project originated was a simple inquiry about the cosmic identity of comets at the dawn of the astronomical revolution: how did natural philosophers and astronomers define the nature and place of a new category of celestial objects – comets – after Brahe’s estimation of cometary distances? It was from this turning point in the history of cometary theories that I expanded my studies in both the pre-modern and modern eras. A study starting merely from Brahe and ending with Newton, without covering classical and medieval thought about comets, would be incomplete and leave the fascinating achievements of post-Newtonian cometology unexplored.
Thoroughly updated to include exciting discoveries from spacecraft missions and laboratory analyses, as well as new teaching resources.
THE MEETING The IAU Symposium 160 ASTEROIDS COMETS METEORS 1999 has been held at Villa Carlotta in Belgirate, on the shore of Lago Maggiore (Italy), from June 14 to June 18, 1993. It has been organized by the Astronomical Observatory of Torino and by the Lunar and Planetary Institute of Houston. It has been a very large meeting, with 323 registered participants

from 38 countries. The scientific program included 29 invited reviews, 106 oral communications, and 215 posters. The subjects covered included all the aspects of the studies of the minor bodies of the solar system, including asteroids, comets, meteors, meteorites, interplanetary dust, with special focus on the interrelationships between these. The meeting was structured as follows. 5 morning plenary sessions have been devoted to invited reviews on: (1) search programs (2) populations of small bodies (3) dynamics (4) physical observations and modelling (5) origin and evolution. Two afternoon plenary sessions have been devoted to space missions to small bodies and to interrelationships between the different populations. The afternoon parallel sessions have been devoted to: dynamics of comets; Toutatis, Ida, Gaspra; physical processes in cometary comae and tails; meteorites; the cosmogonic message from cometary nuclei; physics of asteroids; the interplanetary dust complex; comet nuclei; meteors; composition and material properties of comets; dynamics of asteroids.

A look at the role comets may have played in the origins and evolution of life, particularly in light of recent investigations of Halleys comet, new insights into organic synthesis in meteorites and comets, and new results of numerical simulations of cometary orbits and impacts on Earth. This is a comprehensive review of current research, accessible to graduate students and others new to the field. Each chapter was prepared by an expert in the field, and carefully revised by the editors for uniformity in style and presentation.

The annual meeting of the Astronomische Gesellschaft in Cologne, June 1988, featured extensive reviews of the chemical processes relevant to astrophysics. The twelve contributions to this book, written by experts from the US, UK, France, Belgium, Switzerland and Germany, deal in depth with the chemistry of comets and meteorites, of stars and their shells, of the interstellar medium and galaxies. A comprehensive review of nucleosynthesis and two reports on observations round off an up-to-date presentation of cosmic chemistry.

Physics and Chemistry of the Solar System is a broad survey of the Solar System. The book discusses the general properties and environment of our planetary system, including the astronomical perspective, the general description of the solar system and of the sun and the solar nebula). The text also describes the solar system beyond mars, including the major planets; pluto and the icy satellites of the outer planets; the comets and meteors; and the meteorites and asteroids. The inner solar system, including the airless rocky bodies; mars, venus, and earth; and planets and life about other stars, is also encompassed. Mathematicians, chemists, physicists, geologists, astronomers, meteorologists, and biologists will find the book useful.

The Foundation for Advances in Medicine and Science (FAMS), the organizers of SCANNING 98, sponsored its third annual Atomic Force Microscopy/Scanning Tunneling Microscopy Symposium at the Omni Inner Harbor Hotelin Baltimore, Maryland, from May 9 to 12, 1998. This book represents the compilation of papers that were presented at the AFM/STM Symposium as well as a few that were presented at SCANNING 96 and SCANNING 97 meetings that took place in Monterey, California. The purpose of the symposium was to provide an interface between scientists and engineers, representatives of industry, government and academia, all of whom have a common interest in probe microscopies. The meetings offered an ideal forum where ideas could easily be exchanged and where individuals from diverse fields who are on the cutting edge ofprobe microscopy research could communicate with one another. Experts in probe microscopy from around the world representing a wide range of disciplines including physics, biotechnology, nanotechnology, chemistry, material science, etc., were invited to participate. The format of the meeting was structured so as to encourage communication among these individuals. During the first day’s sessions papers were presented on general topics such as application of scanning probe microscopy in materials science; STM and scanning tunneling spectroscopy of organic materials; fractal analysis in AFM; and nanomanipulation. Other papers presented included unexpected ordering of a molecule; synthesis ofpeptides and oligonucleotides; and analysis oflunar soils from Apollo 11.

As a star in the universe, the Sun is constantly releas- cover a wide range of time and spatial scales, making ?? ing energy into space, as much as ?. ? ?? erg/s. Tis observations in the solar-terrestrial environment c- energy emission basically consists of three modes. Te plicated and the understanding of processes di?cult. ?rst mode of solar energy is the so-called blackbody ra- In the early days, the phenomena in each plasma diation, commonly known as sunlight, and the second region were studied separately, but with the progress mode of solar electromagnetic emission, such as X rays of research, we realized the importance of treating and UV radiation, is mostly absorbed above the Earth’s the whole chain of processes as an entity because of stratosphere. Te third mode of solar energy emission is strong interactions between various regions within in the form of particles having a wide range of energies the solar-terrestrial system. On the basis of extensive from less than ? keV to more than ? GeV. It is convenient satellite observations and computer simulations over to group these particles into lower-energy particles and thepasttwo decades, it hasbecomepossibleto analyze higher-energy particles, which are referred to as the so- speci?cally the close coupling of di?erent regions in the lar wind and solar cosmic rays, respectively. solar-terrestrial environment.

Divided into two parts, the first four chapters of Comets and their Origin refer to comets and their formation in general, describing cometary missions, comet remote observations, astrochemistry, artificial comets, and the chirality phenomenon. The second part covers the cometary ROSETTA mission, its launch, journey, scientific objectives, and instrumentations, as well as the landing scenario on a cometary nucleus. Along the way, the author presents general questions concerning the origin of terrestrial water and the molecular beginnings of life on Earth, as well as how the instruments used on a space mission like ROSETTA can help answer them. The text concludes with a chapter on what scientists expect from the ROSETTA mission and how its data will influence our life on Earth. As a result, the author elucidates highly topical and fascinating knowledge to scientists and students of various scientific backgrounds, allowing them to work with ROSETTA's data.

The study of comets is a field that has seen tremendous advances in recent years, far surpassing the knowledge reflected in the original Comets volume published as part of the

Space Science Series in 1982. This new volume, with more than seventy contributing authors, represents the first complete overview of comet science in more than a decade and contains the most extensive collection of knowledge yet assembled in the field. Comets II situates comet science in the global context of astrophysics for the first time by beginning with a series of chapters that describe the connection between stars and planets. It continues with a presentation of the formation and evolution of planetary systems, enabling the reader to clearly see the key role played in our own solar system by the icy planetesimals that were the seeds of the giant planets and transneptunian objects. The book presents the key results obtained during the 1990s, in particular those collected during the apparition of the exceptional comets C/Hyakutake and C/Hale-Bopp in 1996-1997. The latest results obtained from the in situ exploration of comets P/Borrelly and P/Wild 2 are also discussed in detail. Each topic of is designed to be accessible to students or young researchers looking for basic, yet detailed, complete and accurate, information on comet science. With its emphasis on the origin of theories and the future of research, Comets II will enable scientists to make connections across disciplinary boundaries and will set the stage for discovery and new understanding in the coming years.

Physics and Chemistry of the Solar System focuses on planetary physics and chemistry. This book consists of 12 chapters. Chapters I to IV cover the general properties and environment of the planetary system. The solar system beyond Mars is elaborated in Chapters V to VIII, while the inner solar system is considered in Chapters XI to XII. In these chapters, this compilation specifically discusses the limitations on big bang nucleosynthesis; structure and classification of galaxies; and mass and angular momentum distribution. The radio wave propagation in space plasmas; interiors of Jupiter and Saturn; density and composition of icy satellites; and evaporation and non-gravitational forces are also deliberated. This text also explains the physical properties of meteorites; geology of the Moon; geophysical data on Mars; and search for extraterrestrial intelligence. This publication is a good reference for first-year graduate students who intend to take graduate courses in specialized areas of planetary sciences, as well as practicing Ph.D. scientists with training in physics, chemistry, geology, astronomy, meteorology, and biology.

As this excellent book demonstrates, the study of comets has now reached the fas cinating stage where we understand comets in general simple tenns while, at the same time, we are uncertain about practically all the details of cometary nature, structure, processes, and origin. In every aspect, even including dynamics, a choice among several or many competing theories is made impossible simply by the lack of detailed knowledge. The space missions, snapshot studies of two comets, partic ularly the one that immortalizes the name of Sir Edmund Halley, have produced a huge mass of valuable new infonnation and a number of surprises. Nonetheless, we face the tantalizing realization that we have obtained only a fleeting glance at two of perhaps a hundred billion (lOll) or more comets with possibly differing natures, origins, and physical histories. To my personal satisfaction, comets seem to have discrete nuclei made up of dirty snowballs, as I concluded four decades ago, but perhaps they are more like frozen rubbish piles.

This book goes beyond a phenomenological study to present a detailed quantitative treatment of the dynamic interactions between stars and interstellar matter. Emphasizing a practical understanding of these processes, the text is interlaced with mathematical derivations that are understandable by anyone with an undergraduate background in Physics.

Pt.2: Flyby missions and systematic observations of comets are projected for studying comet nuclei and cometary dust tail structures.

and In the IAU Symposium of 1979 devoted to interstellar molecules [8]. Excellent relevant monographs [9. 10] . related timely proceedings [11] . and recently published elementary textbooks [12. 13] further help to define the pedagogical scope of molecular astrophysics. A significant financial investment has been made in the establishment of ground- and satellite-based observationai facilities for molecuiar astrophysical studies. In the coming years. a wealth of experimental data is bound to accumulate. in which connection close interactions between observers. astrophysical modeliers. and molecular physicists and chemists can play a helpful role in analysis and interpretation. In view of the increasing pace of activity in the field of molecular astrophysics. and in the apparent absence of relevant international meetings since the Liege 1977 and IAU 1979 Symposia. it was deemed appropriate and timely by the organizers to hold a workshop in 1984. Consequently. the NATO Advanced Research Workshop. "Molecular Astrophysics State of the Art and Future Directions". was organized and held at Bad Wlndshelm. West Germany. from 8 to 14 July 1984. The choice of speakers and subject matter of the Workshop was largely subjective. but designed to include most of the generally accepted areas of molecular astrophysical study. Workers from the fields of radio. infrared. and uv-optlcal observations. astrophysical modelling. laboratory spectroscopy. reaction chemistry. collision physics. and theoretical molecular physics and chemistry. were Invited to present survey lectures In their areas of speciality. In addition.

Written by a leading expert on comets, this textbook is divided into seven main elements with a view to allowing advanced students to appreciate the interconnections between the different elements. The author opens with a brief introductory segment on the motivation for studying comets and the overall scope of the book. The first chapter describes fundamental aspects most usually addressed by ground-based observation. The author then looks at the basic physical phenomena in four separate chapters addressing the nucleus, the emitted gas, the emitted dust, and the solar wind interaction. Each chapter introduces the basic physics and chemistry but then new specific measurements by Rosetta instruments at comet Churyumov-Gerasimenko are brought in. A concerted effort has been made to distinguish between established fact and conjecture. Deviations and inconsistencies are brought out and their significance explained. Links to previous observations of comets Tempel 1, Wild 2, Hartley 2, Halley and others are made. The author then closes with three smaller chapters on related objects, the loss of comets, and prospects for future exploration. This textbook includes over 275 graphics and figures--most of which are original. Thorough explanations and derivations are included throughout the chapters. The text is therefore designed to support MSc. students and new PhD students in the field wanting to gain a solid overview of the state-of-the-art.

Comet nuclei are the most primitive bodies in the solar system. They have been created far away from the early Sun and their material properties have been altered the least since their formation. Thus, the composition and structure of comet nuclei provide the best information about the chemical and thermodynamic conditions in the nebula from which our solar system formed. In this volume, cometary experts review a broad spectrum of ideas and conclusions based on in situ measurement of Comet Halley and remote sensing observations of the recent bright Comets Hale-Bopp and Hyakutake. The chemical character of comet nuclei suggests many close similarities with the composition of interstellar clouds. It also suggests material mixing from the inner solar nebula and challenges the importance of the accretion shock in the outer nebula. The book is intended to serve as a guide for researchers and graduate students working in the field of planetology and solar system exploration. Several special indexes focus the reader's attention to detailed results and discussions. It concludes with recommendations for laboratory investigations and for advanced modeling of comets, the solar nebula, and the collapse of interstellar clouds.

A quantitative introduction to the Solar System and planetary systems science for advanced undergraduate students, this engaging new textbook explains the wide variety of physical,

chemical and geological processes that govern the motions and properties of planets. The authors provide an overview of our current knowledge and discuss some of the unanswered questions at the forefront of research in planetary science and astrobiology today. They combine knowledge of the Solar System and the properties of extrasolar planets with astrophysical observations of ongoing star and planet formation, offering a comprehensive model for understanding the origin of planetary systems. The book concludes with an introduction to the fundamental properties of living organisms and the relationship that life has to its host planet. With more than 200 exercises to help students learn how to apply the concepts covered, this textbook is ideal for a one-semester or two-quarter course for undergraduate students.

The study of Comet Halley in 1986 was a tremendous success for cometary science. In March of that year, six spacecrafts passed through Comet Halley as close as 600 km from the nucleus and made the in situ measurements of various kinds. These space missions to Comet Halley and that of the ICE spacecraft to Comet Giacobini-Zinner combined with studies, both ground-based and above the atmosphere, have increased our knowledge of cometary science in a dramatic way.This new edition of Physics of Comets incorporates these new and exciting findings. The emphasis of the book is on the physical processes operating in a cometary environment. It discusses up-to-date observations, methods and results based on the study of various comets. The subject is developed in a systematic manner covering various aspects of cometary phenomena. This book may serve as a text book for students, and as reference material for researchers.

This book focuses on the most recent, relevant, comprehensive and significant aspects in the well-established multidisciplinary field Laboratory Astrophysics. It focuses on astrophysical environments, which include asteroids, comets, the interstellar medium, and circumstellar and circumplanetary regions. Its scope lies between physics and chemistry, since it explores physical properties of the gas, ice, and dust present in those systems, as well as chemical reactions occurring in the gas phase, the bare dust surface, or in the ice bulk and its surface. Each chapter provides the necessary mathematical background to understand the subject, followed by a case study of the corresponding system. The book provides adequate material to help interpret the observations, or the computer models of astrophysical environments. It introduces and describes the use of spectroscopic tools for laboratory astrophysics. This book is mainly addressed to PhD graduates working in this field or observers and modelers searching for information on ice and dust processes.

The Encyclopedia of the Solar System, Third Edition—winner of the 2015 PROSE Award in Cosmology & Astronomy from the Association of American Publishers—provides a framework for understanding the origin and evolution of the solar system, historical discoveries, and details about planetary bodies and how they interact—with an astounding breadth of content and breathtaking visual impact. The encyclopedia includes the latest explorations and observations, hundreds of color digital images and illustrations, and over 1,000 pages. It stands alone as the definitive work in this field, and will serve as a modern messenger of scientific discovery and provide a look into the future of our solar system. New additions to the third edition reflect the latest progress and growth in the field, including past and present space missions to the terrestrial planets, the outer solar systems and space telescopes used to detect extrasolar planets. Winner of the 2015 PROSE Award in Cosmology & Astronomy from the Association of American Publishers Presents 700 full-color digital images and diagrams from current space missions and observatories, bringing to life the content and aiding in the understanding and retention of key concepts. Includes a substantial appendix containing data on planetary missions, fundamental data of relevance for planets and satellites, and a glossary, providing immediately accessible mission data for ease of use in conducting further research or for use in presentations and instruction. Contains an extensive bibliography, providing a guide for deeper studies into broader aspects of the field and serving as an excellent entry point for graduate students aiming to broaden their study of planetary science.

Predicted long ago to be present on the surface of planetary bodies by theoreticians and recently shown by interplanetary spacecraft and ground- based instruments to be ubiquitous in the Solar System, ices in a broad sense have become an extremely important subject in planetary research. Ices found on objects formed in the remote parts of the Solar System contain a message about the composition and mode of formation of our planetary system. There are also objects that contain icy materials that bear signatures of past events on a geological timescale. Their study is one of the best means of inquiring about the origins, accessing the past and anticipating the future of our Solar System. The reviews in this book collect together a series of papers covering the physics and chemistry of ices, as well as the geology of icy surfaces. They present an extensive summary of their chemical and physical properties relevant to planetary astronomy. They also provide an overview of planetary bodies that contain ices and the outstanding problems of the field. Audience: The book is intended to become a reference for researchers and graduate students. It is accessible to senior graduate students with a background in planetary science.

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The book covers the field of solar system astrophysics beginning with basic tools of spherical astronomy and coordinate frames and celestial mechanics. It therefore presents equations and derivations starting from a level that permits one to see the underlying physical ideas. An up-to-date overview on all essential topics is presented, but is concise where possible. The text is based on extensive experience in the classroom and its contents have been field-tested by students for years. The material has been updated in the last few months to take advantage of the newer discoveries of the Mars Rover and the Saturn Cassini missions.