BOOK REVIEWS

Exploring Mercury: The Iron Planet

ROBERT G. STROM AND ANN L. SPRAGUE

Springer Praxis Books; 216 pp.; ISBN 1-85233-731-1; 2003; $39.95.

Planet Mercury is both difficult to observe and difficult to reach by spacecraft. Just one spacecraft, Mariner 10, flew by the planet 30 years ago. An upcoming NASA mission, MESSENGER, will be launched this year and will go into orbit around Mercury at the end of this decade. A European mission is planned for the following decade. It's worth going there because Mercury is a strange body and the history of planetary exploration has taught us that strangeness gives us insight into planetary origin and evolution.

Mercury is intrinsically the densest of the planets and it must be iron-rich. Perhaps not coincidentally, it has a significant magnetic field, which may mean that it can generate a field, much as Earth generates a field. Yet Mercury is small; it has an old, heavily cratered surface, and very little atmosphere. It also has unusual spectroscopic and radar characteristics. We understand it far less well than any other planet inward of Uranus.

Given its special character, it is perhaps not surprising that Mercury has a "fan club" of scientists who are intrigued and enticed by this mysterious object. Two of these fans, Bob Strom and Ann Sprague, have written *Exploring Mercury: The Iron Planet*, and ably explain why it is an interesting planet. The authors are professional planetary scientists who have made major contributions to our understanding of the surface and atmosphere of Mercury, as well as other planets. Their approach is partly historical, partly pedagogical, and partly a lengthy scientific review. This makes much of the text accessible to the scientifically literate layperson and all of it accessible to scientists, not just experts.

Perhaps wisely, the authors have not attempted a synthesis or pushed a personal view of why Mercury is the way it is. For that reason, the book does not include anything that is particularly new. Still, it is all in one place, comprehensive and even-handed, and is therefore useful to planetary scientists, as well as others seeking a summary of what we know and what we would like to know. In a few instances, the authors have avoided the challenge of some topics that are important yet technically demanding, such as an explanation of why Mercury is in a 3:2 spin orbit resonance. It is actually not that hard to explain why such a resonance might exist (that is, have stability)—though it is not at all obvious why Mercury chose this resonance rather than some other, such as 5:2, 2:1, or 1:1.

The book contains good illustrations and some nice graphics that are pedagogical in nature, as well as some figures from published papers. It also includes a CD containing images, including those of highest resolution, from the Mariner 10 mission. The referencing is up-to-date and the text is well written. A serious planetary scientist would probably want to have the University of Arizona series book on Mercury at hand (though it is over a decade old) and access to some of the recent published papers. However, for teaching purposes and background reading, this is an excellent basic- to mid-level text.

— David J. Stevenson, California Institute of Technology, Pasadena

The High-Latitude Ionosphere and its Effects on Radio Propagation

ROBERT D. HUNSUCKER AND JOHN K. HARGREAVES

Cambridge Atmospheric and Space Science Series; Cambridge University Press, U.K.; ISBN 0-521-33083-1; xiii+617 pp.; 2003; $140.

The ionosphere is indeed the place where Earth and space come together. Correspondingly, the ionosphere is subject to the details and complexities of both Earth and space. If one is to develop a logical understanding of even a limited portion of the ionosphere, that knowledge will be constructed on a foundation of many facts of nature. Awareness of those facts will in turn be supported by a vast historical array of scientific effort to ascertain the fundamentals of Earth and space that combine to form the ionosphere as we know it. Fortunately for us, R. D. Hunsucker and J. K. Hargreaves have written a book that goes from the Earth up and comes from the Sun down to arrive at a remarkably detailed physical description of the ionosphere and its impact on human activities, especially radio-frequency (RF) communications.

The High-Latitude Ionosphere and its Effects on Radio Propagation is a bit of a misnomer, because the book covers many more topics than its title suggests. The authors set the stage by developing a detailed picture of the density, temperature, chemical, neutral, and charge states of the atmosphere-ionosphere system. Basic models of the ionization and recombination processes are presented with supporting mathematics and graphical examples. Concepts such as the Chapman production function are introduced and applied, whereby ionizing solar radiation produces electron-ion pairs. One can then grasp how the so-called D, E, and F layers of the ionosphere are related to the ionization of specific molecular species. Along the way, the authors are careful to introduce the extensive nomenclature of ionospheric descriptors. There is a comfortable relationship of prose, mathematics, and graphical material. Reading this book is a pleasure for the scientifically curious mind.

Having described the basics of the ionosphere, the authors then focus on higher-order effects caused by the Earth's diurnal rotation, the geomagnetic field, the solar wind, and the interplanetary magnetic field. Here things get really interesting, and the focus of the book on the high-latitude ionosphere comes into play.

Magnetic field lines that directly connect the northern and southern hemispheres form the magnetic trap that contains the Van Allen belts. If the Earth were isolated in free space, one might expect field lines to leave one hemisphere and return to the other up to arbitrarily high latitudes. With the solar wind and interplanetary magnetic field distorting the Earth's field, solar-borne plasma is injected on open field lines into the ionosphere at high latitudes, creating an environment that is significantly different from that at mid-latitudes. Phenomena such as coronal mass ejections cause significant variability of the solar wind, which in turn drives major changes in ionospheric phenomena such as aurora, ring currents, and magnetic storms. The authors take us through a wide range of driving forces, from space-based events to upper atmospheric wind patterns, to explain a variety of ionospheric observables.

Once the ionospheric fundamentals have been described, most of the rest of the book is directed to electromagnetic RF propagation in the ionosphere, with an emphasis on high-latitude conditions. There is a good balance between practical applications and RF probing of the ionosphere for basic research. Ionospheric science begins with very elementary, yet complex, physical principles, such as the Appleton equation, Eq. (3.47); then it transitions into a vast domain of phenomenology with a plethora of acronyms. This reviewer appreciates the authors' efforts to mitigate acronym soup with things like Tables 3.1 and 3.6. The authors' sense of humor regarding the Appleton equation is also entertaining.

When reading a book of this scale, technical accuracy is an important consideration. I have checked many of the equations and have found only a few problems. What I have found appear to be of a typographical nature. For instance, I believe the scale height is missing in Eq. 3.34; albeit, this appears to be corrected in Eq. 3.37. As another example, I believe that Eq. 4.2 should read $A(30\ \text{MHz}) = A(f)f^2/(30)^2$ rather than $A(30\ \text{MHz}) = A(f)(30)^2/f^2$ if it is to match the text. On the related matter of clarity of presentation, I find most of this book to be very good.

For example, Figure 3.20 is quite helpful in illustrating the concept of scintillation. By contrast, a few additional, well-chosen words in some places could have enhanced clarity. For instance, my physics background helps me understand the meaning of Figure 3.22, but I wish more detail had come with it. Admittedly, judgment calls of this nature are necessary to avoid an intractably long book.

In total, I am very pleased with *The High-Latitude Ionosphere and its Effects on Radio Propagation* and rate it highly. It is indeed worthy of serious students of the ionosphere, and it covers a range of interest far greater than the title suggests.

—RONALD W. MOSES, Jr., Los Alamos National Laboratory, New Mex.