Plasmas on a planetary scale

Physics of the Jovian Magnetosphere

A. J. Dessler, ed.
544 pp. Cambridge U.P., New York, 1983. $29.50

Reviewed by Margaret Galland Kivelson

Timely, thorough, systematic, beautifully produced and fairly priced, *Physics of the Jovian Magnetosphere* is a thoroughly satisfying book. One hopes that it will win the attention of a wide group of readers, including most plasma physicists studying the solar-system. They will gain new insights into other problems of direct interest to them by learning about the behavior of plasmas in the vicinity of Jupiter, with its large spatial scale, rapid rotation and internal plasma sources.

Jupiter's magnetosphere differs significantly from others that have been investigated because its moon Io serves as an important source of magnetospheric heavy-ion plasma. Currents that flow between Io, its associated torus-shaped ion cloud, and the planetary ionosphere exert the satellite's influence on the magnetosphere but are, in turn, affected by the electrical conductivity of the ionosphere. The specifics of the interaction are complex, and questions related to particle sources, transport, losses and wave-generation mechanisms are only slowly being unraveled. An additional way in which Jupiter's magnetosphere differs from others is that it acts as a source of energetic particles that penetrate interplanetary space to large distances. The mechanisms that accelerate these particles and lead to their discharge are not yet understood.

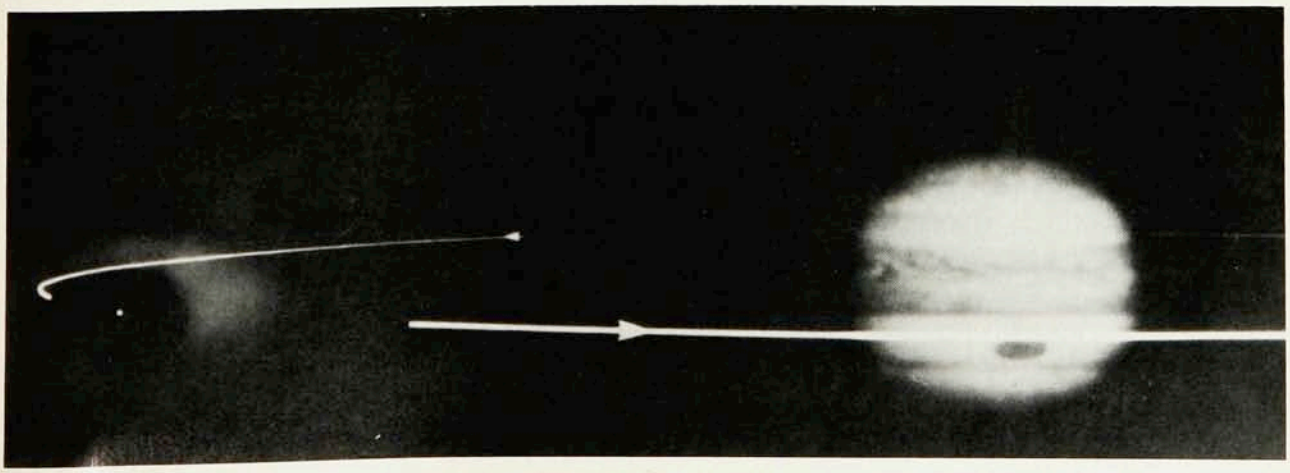
The analysis of the Jovian environment rests on an increasingly complete observational base. Data from the Pioneer and Voyager missions provide complementary coverage, particularly in the antisolar hemisphere. Additional information is available from ground-based observations taken over many years. These data have sharpened questions raised in the past. In the next few years efforts to identify unsettled issues will undoubtedly intensify, in order that the measurements to be made by the scheduled Galileo spacecraft (Jupiter arrival: 1988) contribute as effectively as possible to resolving ambiguities.

In the continuing effort to understand the environment of Jupiter, *The Physics of the Jovian Magnetosphere* will be an invaluable reference. The useful predecessor to this book (*Jupiter*, edited by T. Gehrels, 1976) is dated, for it preceded the Voyager flybys. Those flybys overturned earlier interpretations by identifying a source of ions at the orbit of Io. They also extended the information on radio emissions and gave the first measurements of plasma waves, subjects discussed fully in the present book.

The book reveals the editor's knowledge of the subject and, equally importantly, that of his colleagues. He recruited authors who know their subjects and know how to present them. The coverage of relevant material is remarkably thorough. Eight of the dozen separately authored papers are primarily phenomenological. Most of these rely on spacecraft data, but two include extensive discussion of ground-based observations. The remaining four papers are theoretical. Vytenis M. Vasyliunas's chapter comprises a veritable handbook of magnetohydrodynamics. Having explained what the theory requires, he analyzes much of the relevant literature in a critical manner, an informative exercise in nosology.

An appendix giving symbols and acronyms for the entire volume and a unified reference list attest to the editor's efforts to integrate the sepa-

Margaret Galland Kivelson is a professor of earth and space science and a member of the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles.



The magnetosphere of Jupiter holds particles of sodium and oxygen in a torus circling the planet. The images of Io and the torus were taken from Earth. The photo of Jupiter, from a Voyager spacecraft, is superimposed at the same scale. (JPL, Courtesy Louis Lanzerotti) rate contributions. He deserves commendation for his success in achieving uniformly high standards of presentation, thorough coverage and minimum overlap.

Lie Algebras in Particle Physics

Howard Georgi
255 pp. Benjamin/Cummings, Reading, Mass, 1982. $19.95

The most useful techniques for classifying elementary particles and their interactions require a knowledge of Lie algebras and their representations. Howard Georgi's new textbook is an introduction to these techniques. Although the book is written at an elementary level and does not require quantum field theory, it describes many applications of group theory to particle physics in a compelling manner. It also describes the root and Dynkin diagrams of the simple Lie algebras and a little about their representations.

The range of application of group theory in particle theory is now so broad that it is important to become familiar with it as early as possible. This textbook is written for (very motivated) advanced undergraduates and beginning graduate students interested in particle physics. It is no trivial matter to write an introductory book on this subject, because developing the mathematics fully requires long algebraic proofs and abstract arguments, and covering the many facets of the physics is complicated. Although fully qualified to do both, Georgi is careful to do only a little of each, but enough so that by the end of the book (and the semester), the student will have both a clear physical understanding of why this mathematics is relevant and a feeling for the structure of modern particle theory. As students learn more particle theory, they will become grateful to learn just how useful Georgi's book is. It provides physical insight with mathematically simple examples. Georgi does not fall into the trap of showing off his expertise with lengthy calculations (which are easy enough to find). Instead he selects examples of the mathematics and physics that are conceptually significant but require little paper to work out. Only rarely does he stray from the most important topics. Essentially everything in the book is indispensable to the practicing particle physicist. Naturally, in paring down this gigantic field to an introductory course, he has had to leave out many important details, but much of that material can be left to a more advanced course.

I found the book delightful to read; many other physicists should enjoy it, too. Instead of completing group theory with abstract or lengthy proofs, Georgi uses examples, especially SU(2) and SU(3), to make the results believable. The examples are well chosen; the beginner will be astounded by the power and simplicity of the arguments. (However, Georgi is very careful to warn the reader not to become too enamored of the mathematics alone.) Although the price of its simplicity is occasional glibness, the book makes the most of informality without sacrificing too much rigor.

The book contains roughly equal parts of group-theoretic fundamentals, physical applications (isospin, eightfold way, SU(6), electroweak theory, QCD, and unified theories) and taxonomy of simple Lie algebras. Roots systems and Dynkin diagrams are emphasized. Although much of this material has been predigested for physicists in a wonderful book by Brian Wybourne (*Classical Groups for Physicists*, 1974), I believe that aspiring particle physicists will find that the narrower focus of Georgi's book makes it easier to follow.

The book is brilliant in conception and always competent in execution. It is an excellent addition to the all-too-small library of contemporary elementary-particle textbooks.

RICHARD SLANSKY
Los Alamos National Laboratory

Introduction to Nonlinear Laser Spectroscopy

M. D. Levenson
256 pp. Academic, New York, 1982. $29.50

The advent of tunable lasers has revolutionized optical spectroscopy. The immense research activity in this area is manifested by the ever-increasing number of publications during the past 15 years. This prolific phase of optical spectroscopy stems from the development of new spectroscopic techniques using the high intensity, narrow collimation and extreme monochromaticity of laser sources. These techniques have opened up possibilities of probing atomic and molecular structure in incredibly fine detail. They have also found applications in many other disciplines of science and technology, ranging from physics, chemistry, biology and medical science to isotope separation, combustion and air pollution studies. In a field of rapid growth, it is generally difficult for beginners to learn the essence of the field out of the scattered materials in the literature. Books that can summarize the basic important aspects of the field in a coherent fashion are always most welcome. Marc Levenson's *Introduction to Nonlinear Laser Spectroscopy* is written to fulfill such a need.

The book gives a good survey of various nonlinear optical spectroscopic techniques. In this relatively short monograph, Levenson has succeeded in providing a rather thorough description of a most complete list of techniques: saturation spectroscopy, coherent Raman spectroscopy, multiphoton transitions, optical coherent transients and nonlinear optical sources. (A few interesting areas, such as quantum beats, polarization CARS, Rydberg spectrometry, detection of rare molecules, and multi-level echoes, unfortunately are neglected.) In an attempt to unify the presentation of the various techniques, Levenson uses the two-level Bloch vector model in the description. This choice may indeed help illustrate and connect the principles behind the various techniques, but one should realize that the model is not applicable to all spectroscopic cases. Being an experimentalist, the author puts emphasis on the experimental methods. The book is exceptionally clear and thorough in its presentation of the experimental details. Thus, it should be most useful as a reference for researchers who are interested in adopting some of the techniques in their laboratories.

The main weakness of this book is in the theoretical exposition and physical explanation. They appear to be sketchy and confusing. The basic theory sections in Chapter 2, for example, include hardly any derivations of the equations. Levenson does not explicitly state assumptions and quotes results directly out of the references. He does not emphasize physical pictures alongside the mathematical derivations. He has apparently misjudged the level of an ordinary reader. A beginner would find it difficult to learn about the detailed principles of laser spectroscopy from the book without consulting the extensive lists of references given in the book.

This monograph provides a good introduction to laser spectroscopy to those who have had some familiarity with the field. It should also serve as a useful handbook to experimentalists already working in the field.

Y. R. SHEN
University of California, Berkeley

The Logic of Quantum Mechanics

E. G. Beltrametti, G. Cassinelli
305 pp. Addison-Wesley, Reading, Mass., 1981. $31.50

The "logic of quantum mechanics," as understood in this book, is the study of the mathematical structures that are implicit in standard quantum mechanics or that have been investigated to deepen our comprehension of that theory. The authors largely abstain from