

Plasma Physics for Astrophysics

Russell M. Kulsrud
Princeton U. Press, Princeton, NJ,
2005. \$99.50, \$45.00 paper
(468 pp.). ISBN 0-691-10267-8,
ISBN 0-691-12073-0 paper

Plasma Physics for Astrophysics by Russell M. Kulsrud is the most recent addition to the outstanding series on astrophysics published by Princeton University Press. Like several other titles in the series, Kulsrud's appears destined to become a classic. Just as one turns to James Binney and Scott Tremaine's *Galactic Dynamics* (Princeton U. Press, 1987) for the authoritative word on that subject, students and practitioners of plasma astrophysics will find themselves turning to Kulsrud's "bible." The book's breadth, depth, and superior style and organization, as well

as the intrinsic interest and importance of its subject, will provide rewarding reading for both novices and veterans in the field of plasma processes within astrophysics. Kulsrud, a distinguished faculty member of and professor emeritus in Princeton's astrophysics department and plasma-physics program, is just the person one would wish to have written such a book.

Kulsrud's book is divided into two parts. The first and largest part, chapters 1 through 11, comprehensively lays out the foundational theoretical principles of plasma physics and the well-established phenomena that characterize the dynamical behavior of plasmas. The subjects covered in the chapters include topics treated in general hydrodynamics texts—the equations of magnetohydrodynamics, MHD waves and instabilities, the virial theorem and conservation laws, shock jump conditions, and so forth. Also covered in the book are topics treated in traditional plasma-physics texts, including charged-particle motions and invariants, the plasma dielectric, resonant behavior, wave-wave and wave-particle coupling, and Landau damping, as well as more advanced subjects such as the Braginskii equations.

One of the winning features of Kulsrud's approach is that it mixes highly sophisticated, formal technical derivations with a much more intu-

itive, physical development of concepts. With the insight and wisdom of an experienced researcher and educator, Kulsrud makes an ideal tutor for those new to plasma physics. The narrative style of the book, often colloquial in tone, offers the student a steady hand and calm words of guidance in navigating terrain populated by often formidable-looking equations. The author teaches the student how to face those snarling beasts and defang them, taming the monsters by breaking down each equation into familiar, intuitively understood parts.

The other unique feature of this text, for the audience of astrophysicists, is its context. Unlike many other outstanding graduate-level, plasma-physics books originating in and serving the fusion community, Kulsrud's is concerned exclusively with astronomical systems, from the simple worked examples to the lengthy discussions of research frontiers. The applications discussed cover a huge range, from such classic topics as Faraday rotation of pulsar signals and the Parker instability to more recent topics such as the magnetorotational instability in accretion disks and the Goldreich-Sridhar theory of turbulent MHD cascades.

The final three chapters, 12–14, focus on some of the most important unsolved problems in plasma astrophysics: cosmic-ray acceleration and propagation, magnetic-field generation by dynamos, and reconnection of magnetic fields. Of necessity, Kulsrud's approach in the chapters is more speculative and open-ended than in much of the rest of the book. The dynamo chapter, for example, covers both the techniques and results of the standard α - Ω paradigm as well as more qualitative treatments of other aspects of magnetic field generation in various astrophysical settings. An excellent feature of all three chapters is their presentation of the history of ideas on those topics. In themselves, many of the stories told offer well-chosen object lessons of how scientific theories develop. The author's narration makes those unfinished stories all the more compelling. With the history of Peter Sweet, Eugene Parker, Harry Petschek, and their successors laid out so clearly, future reconnection theorists cannot help but be inspired to push forward toward a resolution!

In summary, *Plasma Physics for Astrophysics* represents a masterful treatment of a subject long overdue for a major exposition. The next generation of scientists will surely benefit from Kulsrud's lifetime of experi-

ence studying and teaching the intricacies of astrophysical plasmas. As each chapter in the book is followed by several problems, the text naturally lends itself to self-study or to use in graduate courses. But like all top-tier textbooks, *Plasma Physics for Astrophysics* will have a life beyond the classroom as a reliable friend and trusted consultant on the shelf and in the hands of the practicing astrophysicist.

Eve C. Ostriker
University of Maryland
College Park

Nuclear Renaissance: Technologies and Policies for the Future of Nuclear Power

W. J. Nuttall
IOP, Philadelphia, 2005. \$79.95
(322 pp.). ISBN 0-7503-0936-9

In *Nuclear Renaissance: Technologies and Policies for the Future of Nuclear Power*, William J. Nuttall of Cambridge University's engineering department considers the possibility that nuclear power will indeed undergo a rebirth. He uses the term renaissance as an analogy comparing the possible rebirth of nuclear power to Europe's emergence from the Middle Ages in the 14th through 16th centuries. The author acknowledges that the book is written from the perspective of North America and western Europe, where nuclear power has yet to gain full public acceptance, unlike in Asia, where use of nuclear power has progressed steadily during the past three decades.

Nuttall does an excellent job of explaining the challenges of any significant future use of nuclear power in the US, Canada, and Europe. He identifies three fundamental policy issues that will shape any nuclear renaissance: the economics of nuclear power, the environmental factors surrounding it, and the security of electricity supplies. The author provides a broad overview of factors that affect whether nuclear power could or should be included in a nation's future energy portfolio. The book combines discussions of energy policy with extensive coverage of technical details on a number of topics unique to the nuclear indus-

