

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.

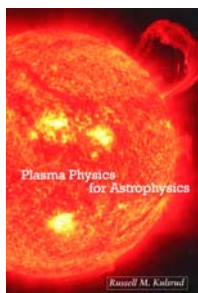
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Nuclear Renaissance: Technologies and Policies for the Future of Nuclear Power

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-



try. The discussion on nuclear waste management is especially relevant—particularly the handling and ultimate disposal of spent nuclear fuel.

In the book's opening chapter, the author identifies the nadir of the nuclear power industry: It was not the accident at Three Mile Island or Chernobyl but rather the decision in the early 1990s to decommission the brand-new Shoreham boiling-water reactor on Long Island, New York. He attributes the decision to the triumph of economists over engineers. Perhaps he is right. But even at the time, the foundations for a future renaissance had been already developed from lessons learned at Three Mile Island and Chernobyl. Today's nuclear power plants are performing at the highest levels in their history. Safe, reliable, cost-effective operations are making the case for the renaissance and are creating favorable trends in public acceptance. Ultimately, Nuttall asserts, the decision will be one of policy, not technology—and that policy will be shaped by the perceived benefits to society, such as reducing the use of fossil fuels and the emissions of greenhouse gases.

Nuttall expresses reservations about nuclear power. In the book's afterword, he admits he would be inclined

to view the world as a better place had nuclear fission never existed. But given that it does exist, he believes that nuclear power deserves to be considered on its merits but with no manifest right to contribute to power generation. Although the book's title might lead one to conclude that the author is an advocate of the use of nuclear power, Nuttall maintains a reserved outlook on whether the renaissance will or should occur. It is refreshing for readers to be able to examine a controversial topic like nuclear power without feeling that the author is pushing an agenda. Most books or articles are either pro or con about the subject. Nuttall's book is nonjudgmental.

I found myself questioning the intended audience for *Nuclear Renaissance*. Those who specialize in policy matters might find the book's complex technical content a little difficult to grasp. However, the extensive use of pictures, diagrams, and charts is very helpful for readers who may be new to the technology of nuclear power.

The book's seventh chapter, on nuclear waste burners, includes discussions of the various technologies associated with spent-fuel management and provides valuable insight into the challenges that exist and their potential solutions. On the other hand, the coverage of nuclear fusion in chapter 9, although interesting, is probably not a legitimate topic to include in a discussion of a nuclear renaissance. Fusion might be part of the future but in all likelihood will not occur in the next 10 years.

I agree with the three fundamental policy issues that Nuttall identifies as crucial to a nuclear renaissance, but I believe gaining public acceptance is also critical and may rely on matters different from those issues. For example, the public must have confidence that nuclear power plant operators place a premium on protecting public health and safety, and that their concern extends to nuclear waste management. In that regard, Nuttall contrasts the difficulties of radioactive waste management that exist in the UK and the US to those that exist in Finland, with its policy and practices of transparency, community volunteerism, and local engagement. He correctly points out the need for scientists and politicians involved in the technical aspects of nuclear power to listen to the concerns of the public and address those concerns.

I note one technical error, on page 179. The helium outlet temperature from a high-temperature, gas-cooled reactor is 1560 °F, not 1560 °C. A dia-

gram on page 180 shows the correct temperature.

Overall, *Nuclear Renaissance* is well researched and well written and makes a valuable contribution to the debate on the future role of nuclear power.

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The End of the Certain World: The Life and Science of Max Born, the Nobel Physicist Who Ignited the Quantum Revolution

Nancy Thorndike Greenspan
Basic Books, New York, 2005.
\$26.95 (374 pp.).
ISBN 0-7382-0693-8

Nancy Thorndike Greenspan tells us that her biography of Max Born was inspired by conversations with his daughter Irene. The strengths and weaknesses of *The End of the Certain World: The Life and Science of Max Born, the Nobel Physicist Who Ignited the Quantum Revolution* may well be linked to the close association with the Born family that Greenspan formed while writing it. Among its strengths are the marvelous photos and the full use of the riches of the Born family archives. Indeed, access to those files has allowed Greenspan to write a double biography, of Max Born but also of his wife Hedwig (Hedi) Ehrenberg Born. But a weakness of the book—the somewhat petulant thesis that Born was never sufficiently credited for his contribution to the creation of quantum mechanics—may also derive from Greenspan's closeness to the Born family.

Greenspan gives two arguments for her claim that Born was slighted. The first is that the history of the formation of quantum mechanics was written mainly by physicists within the intellectual circle of Niels Bohr's Institute of Theoretical Physics at the University of Copenhagen. Greenspan argues that "not being a member of the Copenhagen circle, Born was omitted" (page 148). This strikes me as, at best, not proven. However, her second contention is more credible. It rests on her knowledge of Nobel Prize politics and on some meticulous work in the Nobel Prize archives and is a plausible account of why Born was not chosen to share the 1932 Nobel Prize

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