BOOK REVIEW

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

High-Frequency Plasma Heating

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Reviewer R. L. Freeman

Radio-frequency (rf) waves are used to heat plasmas and drive current in fusion programs worldwide. This book offers a translation and update of a Russian book based on a compilation of papers by Soviet specialists. These papers summarize the physics basis and frequency ranges used for various approaches to heat magnetically confined plasmas and to drive plasma current in toroidal devices using directed waves. Active researchers in fusion and plasma physics are the target audience for this book, and they will find it to be a valuable resource for the specialist. Although the original Russian work was updated to include more recent results, I did not note any reference to work after 1988, so in such a rapidly advancing field, it is still necessary to rely on recent publications and meetings to maintain an up-to-date understanding.

The book offers chapters on electron cyclotron heating, lower-hybrid heating, ion cyclotron heating, and Alfvén heating and current drive. In addition, chapters are included on the topics of noninductive current drive in tokamaks, linear conversion of waves, nonlinear effects in rf heating, and electron cyclotron emission diagnostics.

The treatment of these topics is quite uneven, as can be expected from a compilation written by many different authors. For example, the chapter on ion cyclotron heating is at least a factor of 2 longer than any other. Consequently, it provides a coherent, detailed exposition of the physics of ion cyclotron resonance frequency (ICRF) and an excellent summary of the worldwide experimental status up to 1988. The length of the ICRF chapter partially reflects the complexity and versatility of this approach for plasma heating, and for the most part, the reader comes away with a good understanding of the area. A topic of active current research since this book was first published that is not adequately addressed in the ICRF chapter is the direct damping of fast waves on electrons and the use of these waves to drive the plasma current in the International Thermonuclear Experimental Reactor (ITER) and other large, hot tokamaks.

Chapters on the other heating methods were more concise, but also required a much more detailed understanding of the physics by the reader to follow the explanations. The knowledgeable reader will find that the electron cyclotron and Alfvén chapters provide a good physics foundation and adequate experimental status. The lower hybrid chapter seemed somewhat dated given the substantial experimental progress over the past few years, particularly in the current drive area [Joint European Torus (JET) and JT-60U, for example]. The chapter on noninductive current drive provided an excellent description of the wave physics involved, but the reader needs to be familiar with the physics of tokamaks to appreciate the application. The experimental status in the noninductive current drive chapter is substantially outdated. In general, I encountered several places where symbols were not defined and subscripts were in error, which impeded a quick understanding of the material.

The fusion technologist will be disappointed by this book because very little space is devoted to the means of generating, transmitting, or launching the various waves. The few exceptions to this statement are not inspiring and leave the reader perhaps even more confused. An adequate treatment of the technology status and problems could of course fill an equal-sized volume, so this was not an objective of the present work.

The genesis of this publication as derivative from a Russian book containing invited reviews from Soviet specialists is evident from the predominance of Russian reference sources. This is both a blessing and a fault; many Russian references are cited that may have been overlooked in the West, but the omission of some key Western publications also negates depending on this book as a single reference source.

In summary, I recommend this book as a valuable reference for the specialist in rf heating of plasmas. As indicated previously, this book is targeted at researchers,

not students; no problem sets are included to aid the understanding. The work offers an excellent overview and general explanation of all the major rf heating methods. Major advances in current drive with lower hybrid waves, electron cyclotron waves, and fast waves have been made since 1988, so this book does not provide a very good understanding of the present status in the current drive area. Nonetheless, the physics of wave propagation and absorption was clearly established before 1988, and these topics are well treated by the authors, each in their own style. I think the researcher will find it a ready resource for the fundamental physics of the various heating methods and a source of publications to aid a more detailed exploration of each topic.

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