Book Review

MHD Instabilities. By Glenn Bateman. The MIT Press, Cambridge, Massachusetts (1978). 263 pp. $25.00.

Plasma stability considerations represent a central issue in the search for controlled thermonuclear fusion. A sizable fraction of the literature on fusion plasms deals with stability studies, yet books available on the subject have been limited to encyclopedia-like accounts. Glenn Bateman's *MHD Instabilities* represents a first text written with the student (assumed at the beginning graduate level) in mind. Not only are short questions (with answers) provided, but the approach stresses concepts and techniques while avoiding excessive detailed algebra. Indeed, the presentation is both crisp and lucid (230 pages excluding appendixes). Students I know who have studied the book or the preliminary lecture notes by the author have been enthusiastic about the coverage and style.

Bateman begins with a thorough development of the magnetohydrodynamics (MHD) equations, which are then further explored by an explanatory application to the Rayleigh-Taylor instability in a plane slab. Subsequent chapters deal with equilibrium and the Grad-Shafranov equation, linearized equations, and the energy principle. Specific cases related to cylindrical and toroidal geometries are reviewed including Mercier Criterion implications. High-beta tokamaks, including flux-conserving approaches, are then discussed, followed by brief chapters on nonlinear and resistive instabilities. A final chapter reviews the status of theory versus experiment, another unique feature that sets a standard for future authors of theoretical texts. Key references are cited for various topics and sections in the spirit of providing the reader a ready means of amplifying the discussion rather than proving specific points.

A basic knowledge of variational calculus and tensor analysis is assumed in several sections, but otherwise the mathematical level makes the treatment accessible to persons with a variety of backgrounds. The ~100 questions (with answers in an appendix) interspersed throughout the text should be of special value to beginning students or someone trying to learn this complex subject on his own who needs the added insight and motivation. For classroom use, the instructor will still need to develop his own problems, but Bateman has provided an excellent supplementary set. The glossary of special terms provides another nice aid to the student.

Overall, the outstanding feature of the book is the author's ability to lucidly explain the basic concepts underlying a variety of complex topics previously only covered in research-level discussions. For example, through a mix of discussion, figures, and questions, flux surface topology such as rational surfaces, magnetic islands, and q values are explained, while the tedious topic of flux coordinates (especially Hamada coordinates) is made palatable.

The major shortcoming of this book as a text comes from its somewhat restricted point of view. The focus is strictly on tokamaks to the exclusion of applications to other approaches such as mirrors, pinches, and inertial confinement. Certainly most of the topics carry over to other confinement schemes, but no attempt is made to identify the connection. Likewise, since a first course on stability will typically also consider microinstabilities as well as some aspects of control theory, this text only solves half of the problem for the instructor. Still, this text represents a very important beginning in this young and rapidly growing field. Certainly both students and researchers in the fusion area will want to have *MHD Instabilities* in their personal libraries, and, with its readable style, little dust should accumulate on its cover.

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About the Reviewer: George H. Miley is professor and chairman of nuclear engineering at the University of Illinois, where he has been located since his work on nuclear reactors at the Knolls Atomic Power Laboratory. Dr. Miley's undergraduate studies were at Carnegie Tech, followed by graduate work at the University of Michigan. He is presently involved in several aspects of fusion research, including the development of computational methods for plasma engineering and studies of advanced fuel fusion. His interest and enthusiasm for the development of this text stem from a series of lectures that Dr. Bateman delivered at Illinois when the concept of a book was just beginning to jell.