Book Reviews

Plasma Physics. By E. W. Laing. Crane, Russak and Company, Inc. (1977). 224 pp. $18.50.

This monograph is the fourth in a series entitled "Graduate Student Series in Physics." There is no preface by the General Editor (Douglas F. Brewer of the University of Sussex) and no explanation of what a "graduate student series" is intended to be. If the intention was to provide a brief and readable survey that would whet the appetite of graduate students and induce them to explore further, then Dr. Laing's little book succeeds very well.

The writing is in a breezy, pleasant, informal style. The printing is excellent and misprints are few and far between. It is in no sense a textbook, the coverage of topics being very limited and brief, but the author's own preface makes it clear that there were no intentions along these lines at all.

The eight chapters are divided into two distinct parts. The first four chapters are entitled "An Introduction to Plasma Physics," "Orbit Theory," "Fluid Theory," and "Plasma Kinetic Theory," respectively, and deal with the foundations of the subject. The last four chapters touch on some limited features of research applications and are entitled "Magnetic Confinement of Plasma," "Astrophysical Plasma," "Superdense Plasma," and "Computational Plasma Physics."

To my mind, these last four chapters are the most successful part of the book. I can well imagine a graduate student hungering for more after reading about magnetic confinement ideas or the solar wind and magnetopause or laser pellet compression. As I stated earlier, the writing style is excellent, and I particularly enjoyed these last four chapters, especially the last one on computational methods.

I thought the first four chapters were not quite as successful because the material is more mathematical and detailed and cannot be covered so well in a rapid light style. I was a bit surprised, in Chap. 2, to find no description of the particle drifts using the usual simple pictures of a varying gyration radius in crossed E and B fields or in a straight magnetic field with a perpendicular intensity gradient. Instead, the drifts are derived and discussed in a mathematical way only, using a series expansion about the guiding center. I think the student would have profited by the addition of the diagrams. There are also some annoying misprints in this chapter, on pp. 20 and 21. The treatment of δW in Chap. 3 might be a bit hard to follow, and one would benefit by seeing a simple application or two. I felt the closing section on Chew, Low, Goldberger equations was much too rushed to be comprehensible to a new reader. Chapter 4 is particularly well written, although again the discussion of Landau damping seemed rushed at the end of that section.

In summary, this is an excellent little treatise to put in the hands of an intelligent senior or graduate student who knows little about plasma physics. It is very likely to inspire him to look further into the field. It is unlikely to be of much value to the experienced plasma researcher except as a pleasant, light review. Even so (as happened to me in my reading of Chap. 8), some of the last four chapters may yield an unexpected dividend if one has not thought much about the particular topic covered in them. Those scientists or engineers who have no previous background in plasma physics may or may not find the monograph useful. I would *imagine* that there would be considerable frustration at several points in the first four chapters, where the discussion moves rapidly and lightly over some really complex points.

All in all, this is a good book for the audience it aims at.

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About the Reviewer: Albert Simon returns to these columns with a review of another writing in the field of one of his long-standing interests, initiated more than a score of years ago at the Oak Ridge National Laboratory and followed by associations at General Atomic and the University of Rochester, where he currently holds a professorship in mechanical and aerospace sciences and is chairman of the department. Interspersed in this career have been a Guggenheim Fellowship in Denmark and a Senior Visiting Fellowship at Oxford, plus a sabbatical at the Institute for Advanced Study. Dr. Simon's graduate studies were at Rochester.

Two-Phase Flow and Heat Transfer. By D. Butterworth and G. F. Hewitt, Eds. Oxford University Press, New York (1977). 514 pp. $32.00.

This recent addition to the rapidly growing literature on two-phase flow and heat transfer derives from a series of lectures given at the Harwell and Winfrith Laboratories of the U.K. Atomic Energy Research Group. These establishments, as those familiar with two-phase flow are aware, have made numerous significant contributions to this field in such areas as annular two-phase flow, critical heat flux (CHF), boiling and condensation, and two-phase pressure drop methods. Introductory in nature, the volume benefits from clarity and an evenness of presentation and does not suffer from a surfeit of detail. These qualities attest to the editors' care in assembling the material. The latter quality is important in dispelling the notion that two-phase flow analysis is based only on a selection of arbitrary correlations. This point is expanded in the

Introduction (G. L. Shires).[1] Current plant design, operation, reliability, safety, and economics in the electrical generation, nuclear reactor, and petro-chemical industries require a blend of theoretical methods and empirical data, often combined in a computer code. These needs account for the remarkable growth of interest and activity in this field.

The book is divided into four sections: two-phase flow, two-phase heat transfer, hydrodynamic instability, and condensation. A chapter on loss-of-coolant accidents (LOCAs) in nuclear reactors is appended. Two-phase flow (the book addresses the problem of liquid-gas flow analysis, though much of what is contained is applicable to two-component solid-liquid and solid-gas flows) is a three-dimensional, transient, nonequilibrium phenomenon. Therefore, to provide qualitative insight, flow patterns have been identified to describe the interfacial configuration of the phases (Chap. 2, G. F. Hewitt). Since a complete theoretical description of the two-phase flow problem is beyond current capabilities, one-dimensional flow models (Chap. 3, D. Butterworth) have been developed that, in conjunction with empirical pressure drop methods (Chap. 4, D. Butterworth), enable the analyst to reasonably predict system two-phase pressure drops and flows. The latter chapter treats pressure drop methods in a consistent manner by collecting many of the correlations available, beginning with Lockhart-Martinelli, and indicating the interrelationships that exist between them. Chapters 5 and 6 (G. F. Hewitt) introduce the reader to the vertical bubble, slug, and annular flow regimes. Modeling methods are presented; in particular, the drift-flux approach in bubble and slug flow and the separated flow model in annular flow are emphasized. Considerable expansion of the latter is found in later chapters on boiling and condensation.

The succeeding section on two-phase heat transfer begins with a chapter on pool boiling (D. B. R. Kenning). At risk of being self-contradictory, more fundamental detail would have been desirable here. The process of vapor formation and bubble dynamics is central to our understanding of boiling, and has its counterpart in condensation. At an introductory level, the development of this topic in more depth is justifiable. Also, addition of Zuber's CHF model would have been useful for illustrative purposes. This model is based on local flow instabilities, which play a role in other phenomena of interest such as film boiling breakdown, entrainment, and countercurrent flow. Chapter 8 on nucleate boiling in forced convection (D. B. R. Kenning) and Chaps. 9 and 10 on convective heat in annular flow and estimation methods for forced convection boiling (R. A. W. Shock) provide analysis tools for these flow situations. Designers of evaporators and other horizontal tube heat exchanges (e.g., CANDU reactors) will find Chap. 11 (D. Butterworth and J. M. Robertson) of interest and a source of references for further research. Chapters 12, 13, and 14 (G. L. Shires, G. F. Hewitt, and D. H. Lee, respectively) deal with CHF phenomena. The authors have chosen the term burnout in reference to the marked temperature excursion of a heated surface caused by insufficient liquid cooling of the surface. Though mainly a matter of terminology, I believe the term CHF is preferable. It is generic, suggesting the above condition, without implying wall structural failure or a particular mechanism (departure from nucleate boiling versus dryout). The section in Chap. 12 on use of Freon scaling in the laboratory will be of interest to both the experimentalist and the student, to the latter particularly because of its rhetorical value. The last section in Chap. 14 should be of interest to the nuclear engineer, indicating the possible illusory nature of margins to CHF.

Beginning with Chap. 15, the topics are treated on a more advanced level and become of special interest to those already familiar with the field. The material on fouling effects in boiling water systems (R. V. Macbeth) concentrates on the "wick boiling" model, developed at Winfrith, and its application to boiling from crudded surfaces. Chapters 16 and 17 (N. A. Bailey and R. Potter, respectively) describe two-phase flow stability in boiling systems. Those readers familiar with control theory will find in these chapters an interesting extension to hydrodynamic problems and a useful introduction to a more detailed analysis in Lahey and Moody (*The Thermal-Hydraulics of a Boiling Water Nuclear Reactor*, American Nuclear Society, 1977). Chapters 18 and 19 (D. Butterworth) cover the topic of condensation very well. The final chapter (I. Brittain) on LOCAs, which certainly are a compelling motivation for the study of two-phase flow, was probably an ill-advised addition to this introductory work. This space might have been better utilized in developing other topics of interest (some mentioned in the chapter): critical flow, post-CHF heat transfer, or two-component flows.

In general, the book is well written and quite readable, although certain areas could be improved by a more detailed development of fundamentals (e.g., the conservation equations and the aforementioned section on boiling). The lack of illustrative examples and problems is a definite disadvantage for the student and general reader, leading this reviewer to suggest Collier (*Convective Boiling and Condensation*, 1972) as a possible alternative for classroom use.

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About the Reviewer: Walter Kirchner is a member of the scientific staff of the Los Alamos Scientific Laboratory, and is engaged in thermal-hydraulic analysis of light water reactors. Dr. Kirchner's graduate studies were at the Massachusetts Institute of Technology. He held a reactor operator's license for the N. S. Savannah.

Foundations of Nuclear Engineering. By Thomas J. Connolly. John Wiley and Sons, Inc., New York (1978). $21.95.

This book is aimed at engineers and scientists other than those specializing in nuclear engineering, although I also consider it to be a useful reference for an introductory course in nuclear engineering. Microscopic details of the nuclear reactions important to the exploitation of nuclear energy are adequately presented in elementary terms. Then, the energy-producing reactions—radioactive decay, fission, and fusion—are systematically surveyed for their potential as resources.

The scope of this work is considerably in excess of that implied by the title. The foundations of nuclear engineering—nuclear structure, nuclear reactions, photon interactions with nuclei and electrons—are described, albeit occasionally unevenly and of necessity somewhat superficially; but the rest of the edifice is revealed to a useful extent as well. There are informative sections concerning

[1]Names in parentheses refer to chapter authors.