REVIEWS

Plasma Physics and Magnetofluid Mechanics. By A. B. CAMBEL. McGraw-Hill, 1963. 304 pp. $11.50.

The force of the current technological explosion has created a need for rapid engineering interpretation of scientific disciplines, old as well as new, and this in turn has caused a reorientation of engineering curricula into fields which only yesterday were considered the province of the basic sciences. Professor Cambel has been at the forefront of this conversion at Northwestern University, with his introduction of the subject of the flow of ionized gases into the Department of Mechanical Engineering, and the training of graduate students in this field. Professor Cambel has now taken his lectures and recast them into a text-book for engineers—seniors or graduate students, who are interested in energy conversion, the aerospace sciences, or thermonuclear phenomena. Actually, the centre of gravity of the book is toward the first two areas with very little applicable to the last.

The book is divided into three parts: the first part is concerned with a brief introduction to electrodynamics, the second part deals with the physical chemistry of plasmas, the 'physics' in the title of the book, and the last part deals with magneto-fluid mechanics.

The first chapter introduces some of the present applications and potential engineering uses of plasmas, while the second chapter is devoted solely to units and dimensions. Chapter 3 is an introduction to electricity and magnetism on about the junior level.

Starting with chapter 4, the author deals with the specific properties of plasmas, with this chapter devoted to electromagnetic wave propagation in uniform plasmas with constant properties. The succeeding chapter deals with ionization and recombination mechanisms. Chapter 6 presents the equations of state and composition of gases at high temperature in thermodynamic equilibrium, together with some considerations of radiation, spectra and electron temperatures. This is then followed by a chapter devoted to transport phenomena, including electrical and thermal conduction and viscosity.

The magnetofluid mechanics starts in chapter 8 with the derivation of the global equations from continuum considerations, and the species equations from the Maxwell transport equations. The global equations are 'applied' in the following chapter to obtain the diffusion equation for the magnetic field, Alfvén and magnetoacoustic waves, shock waves in perfectly conducting gases, and similarity parameters. This is followed by some examples of various types of flows, based on classical examples, but with the addition of the Lorentz force and ohmic heating. The book ends with the Kantrowitz–Petschek classification of magnetofluid mechanics regimes.

For the announced purposes of the text, the choice of topics is good. However, its value is diminished by unsatisfactory treatment of many topics. Clear definitions for some symbols are lacking; for example the stationary electric field is not clearly distinguished from the moving electric field. Particularly disconcerting is the lack of a clear definition of a plasma which implies its

continuum property. In addition, some symbols are used to designate two different quantities, while sometimes the same quantity has two different symbols.

In the development of the material of the book, most of the expressions are presented rather than derived, and are usually preceded by a statement that the *definition*, rather than expression, follows. In other cases criteria for the range of applicability are omitted, for example, for the perfect gas law for an ionized gas and for ion slip.

In a few cases, the order of development is reversed. For example, first the expression for the mean free path in a strongly ionized gas is given, then the electron-ion cross-section for momentum transfer. Both of these precede the Spitzer–Härm expression for electrical conductivity, from which they are actually derived, and without cross-referencing. Similarly, the expressions for the transverse and Hall electrical conductivities precede the general expression from which they are derived, again without cross-referencing.

Some developments are also inconsistent. In rapid succession one finds expressions for the various components of the DC electrical conductivity tensor, some of which include ion slip, and some of which do not, with no reason given for the omission or inclusion. In fact, the phenomena of ion slip or drift is not mentioned explicitly. Then again, after introducing the partition function, the thermodynamic functions are presented without reference to the partition function, except for the electronic contributions.

The reader should be particularly wary of the reappearance of formulas throughout the book. For example, there are five expressions for the scalar electrical conductivity, none of which are cross-referenced, and all in terms of different parameters, and even different symbols. The same is true of radiation.

The expository material between the presented expressions suffers from some ambiguity. For example, it is stated that a transverse magnetic field enhances the transition from laminar to turbulent flow, although the accompanying figure shows that the effect is actually inhibition. Also, the statement is made that continuous transition from subsonic to supersonic flow should *not* be expected; and that electrical currents flow in a gas as a result of charge transfer (transport would be clearer). Also, two different expressions are given for magnetoacoustic waves (with different symbols) with no indication as to which is more accurate; actually they are identical. In the same way, two different formulas are given for the electrical conductivity when electron–ion collisions are important. Again, no indication is given as to which is more accurate, but actually they both are minor variations of the same formula! The explanation of the Kantrowitz–Petschek diagram is not particularly clear.

Finally, there are a large number of typographical errors in the equations.

There is little question of the need for engineering students of an introductory text-book which covers the important phenomena, and which will interest the student into taking more extensive courses in electrodynamics, kinetic theory, plasma physics, atomic theory, spectroscopy, statistical mechanics, gaseous discharges, ionization, and fluid mechanics. Future editions of this book may fill this need, if the deficiencies of the current edition are corrected.

G. W. Sutton

SHORTER NOTICES

Reports on Progress in Physics, Vol. XXVI. The Institute of Physics and the Physical Society, 1963. 472 pp. £5

This latest volume in a well-known and respected series contains nine survey articles. The only one with a direct relation to fluid mechanics is by P. A. Sheppard, on 'Atmospheric traces and the study of the general circulation of the atmosphere,' 55 pages in length.

Ninth Symposium (International) on Combustion. Academic Press, 1963. 1091 pp. £15

A mammoth publication, recording 108 of the papers presented at a symposium on combustion held at Cornell University, 27 August to 1 September 1962, under the auspices of the Combustion Institute. Some of the subject headings under which papers are grouped are turbulent and laminar gas flames, spectroscopy, reaction kinetics, detonations, combustion instability, fundamental flame processes, modelling principles, reactions in supersonic flow, and reciprocating-engine combustion. The editor of the proceedings has contributed a valuable four-page introduction which describes the symposium as a whole and the progress reported in various fields. This is primarily a book for the experts, but casual dipping into it will give the lay fluid dynamicist an idea of what is going on in the study of combustion.

Multi-phase Flow Symposium. American Society of Mechanical Engineers, 1963. 99 pp. $6.50

A soft-covered volume, containing the texts of 13 papers presented at an ASME symposium at Philadelphia in November 1963, together with the abstracts of 21 others. The subject of multi-phase flow embraces a wide range of physical processes and phenomena, many of them not well understood.

Gyrodynamics. Edited by H. ZIEGLER. Springer-Verlag, 1963. 303 pp.

This handsomely printed book contains the texts of the 23 lectures given at a symposium organized by the International Union of Theoretical and Applied Mechanics and held at Celerina, Switzerland, in August 1962. The subject of the symposium was problems of gyrodynamics and modern applications of the gyroscope, particularly in the field of inertial navigation, and attracted 62 specialist participants. The book presents an agreeable mixture of fundamental concepts and technical applications.

Dictionary of Pure and Applied Physics. Vol. 1 German–English, Vol. 2 English–German. Compiled by LOUIS DE VRIES and W. E. CLASON. Elsevier. Vol. 1, 367 pp., 31,000 entries, 55*s*.

The two compilers of this new German dictionary bring to their task wide experience of the difficulties that scientists have with foreign languages. As in the case of older scientific dictionaries in French and German by de Vries, some useful non-technical words have been included. The printing is clear and attractive.