

an undergraduate engineering course. The topics are well selected and carefully explained, with good use of examples and analogies. The concepts of random variables and probability distribution and density functions are introduced early, without the usual intervening material on balls and urns and associated combinatorial problems. A disadvantage of this rapid advance is that the concept of the sample space (and the importance of choosing it well) is almost completely neglected. Needless to say, there is no measure theory. The strong law of large numbers is not treated, but there is a careful presentation of the weak law and of the central-limit theorem. Transformations of random variables are not discussed.

A unique feature of the book is an excellent chapter on the elements of statistics in which the meaning and ef-

fective use of the basic probabilistic concepts is well brought out. Among the problems treated are estimation of the mean and variance, confidence intervals and the chi-squared and student tests.

There are two brief chapters on random processes, devoted mainly to elementary properties of covariance functions and power spectral densities. There is a good collection of examples, with hints for the more interesting problems.

The book should serve well as an undergraduate text; in fact, it is the culmination of a set of notes developed over the last 12 years for a course at the Ecole Nationale Supérieure de l'Aéronautique in Paris.

* * *

Thomas Kailath teaches courses in statistical communication theory at Stanford.

Plasmas: equations and instrumentation

KINETIC EQUATIONS OF GASES AND PLASMAS. By Ta-You Wu. 398 pp. Addison-Wesley, Reading, Mass., 1966. \$12.50

INSTRUMENTATION FOR HIGH SPEED PLASMA FLOW. By Allen E. Fuhs. 180 pp. Gordon and Breach, New York, 1966. \$19.50

by *Herbert Malamud*

A kinetic equation for a gas is an equation for the one-particle distribution function $f(x, v, t)$ in the form $\partial f / \partial t = F(f)$, where F is generally a functional of f . The best known example of such an equation is Boltzmann's, introduced in every elementary course in kinetic theory.

Considerable effort and ingenuity have been expended in the past two decades in attempts to improve on Boltzmann's equation. These efforts began with the work of Nikolai Bogoliubov in 1946. He separated the time development into two time scales, the time for a collision and the much longer time between collisions. He obtained a system of equations that could, in principle, be solved to all orders in density. The first order yields the Boltzmann equation. Recently, it has been found that the orders higher than the second diverge. Bogol-

iubov's work was extended by S. T. Choh and George Uhlenbeck, by R. L. Guernsey and others. Edward Frieman and Guido Sandri as recently as five years ago explicitly introduced different variables for the different time scales of Bogoliubov. I. Prigogine and R. Balescu developed an iterative technique to solve the Liouville equation.

Recent interest in plasmas is reflected here also. The long-range Coulomb interaction introduces a divergence into the kinetic equation that is artificially avoided by the introduction of a Debye-length cutoff, such as in the Fokker-Planck and Vlasov equations.

Other methods that utilize this cutoff, explicitly or implicitly, have been developed by Bogoliubov, A. Lenard, and Guernsey, and also by Norman Rostoker and Marshall Rosenbluth and others.

Wu emphasizes in the introduction that the difficulties in describing instabilities of plasmas and divergences in the higher orders of the equations for neutral particles indicate difficulties of a basic nature still remaining in the theory.

The book follows the organization of a seminar series given by the author at the Polytechnic Institute of Brooklyn Graduate Center and elsewhere. The seminar was attended by your re-

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viewer with some profit, and the book will serve well its intended purpose as a graduate text. It is a bit short, however, as a self-study course for those having little prior acquaintance with the subject. Over 150 references and author and subject indexes add to the book's value.

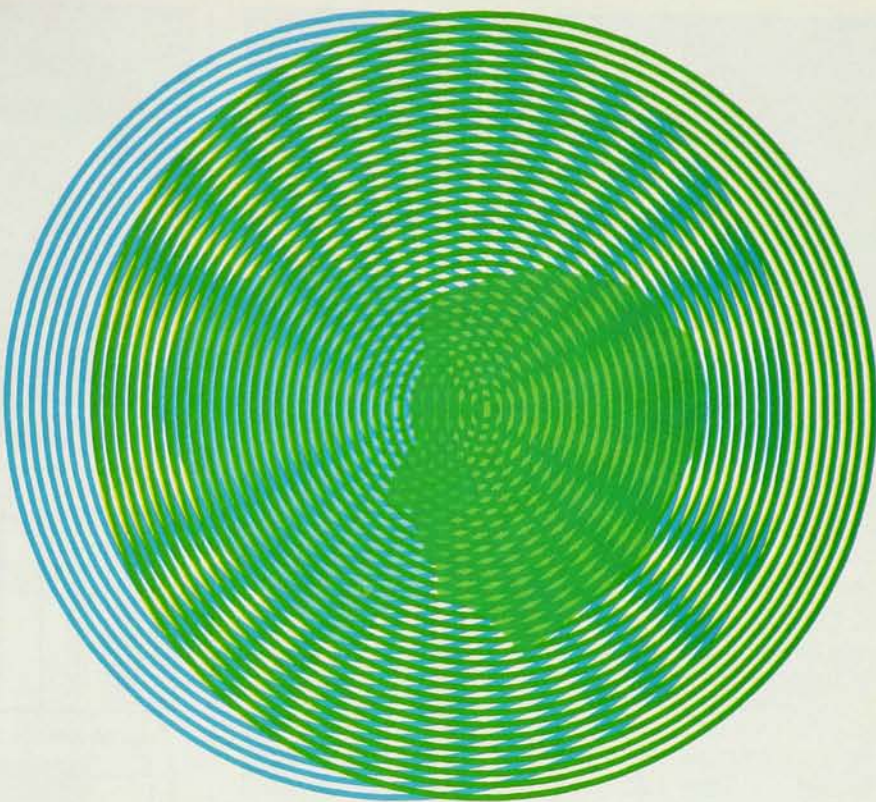
Fuh's *Instrumentation for High Speed Plasma Flow* is a little monograph written by a specialist for specialists. It is a description of a particular way to diagnose some particular types of plasmas.

The type of plasma treated here is changing rapidly in time, either in position or in some other characteristic. Such plasmas include, for example, the sheath that forms around a high-speed vehicle as it enters planetary atmosphere, or the plasma in a high-speed shock tube, or that in an MHD power-generating facility, or in any of a number of other research and practical devices. The instrumentation discussed here consists of a system of coils in which a current flowing at some chosen amplitude, frequency (including zero) and phase is related to the current induced thereby in another coil or coil system. The coupling of the two systems is affected by the plasma of interest, making possible a whole field of plasma diagnostics.

A number of instruments of this class is described. The author has presumably come into contact with them in the course of his work at the Plasma Research Laboratory of The Aerospace Corporation. These instruments measure such parameters as the product of plasma conductivity and velocity, the average electron-collision frequency, the velocity, or determine the presence of turbulence.

The book begins by developing some useful equations and relations, and then describes how the types of signal to be used are developed. There is a section giving typical plasma parameters to be expected in various situations, and the effects of these on signal. Finally there is a description of a number of individual instruments and how they solved particular diagnostic problems.

It is clear that each instrument described is the result of at least several man-years of effort. Anyone who may have a problem he thinks similar to one solved here would be foolish not



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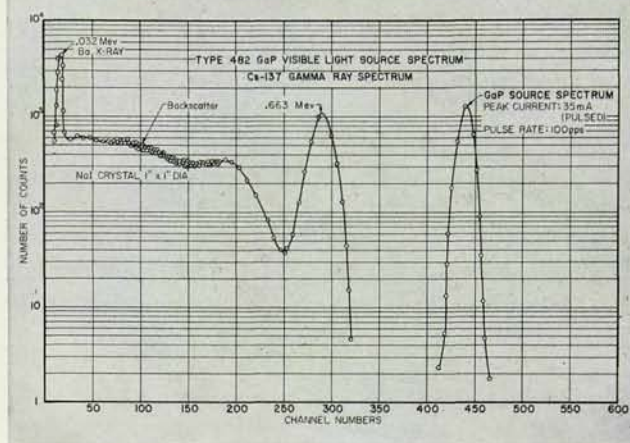
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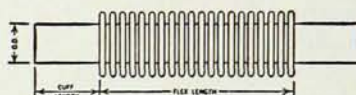
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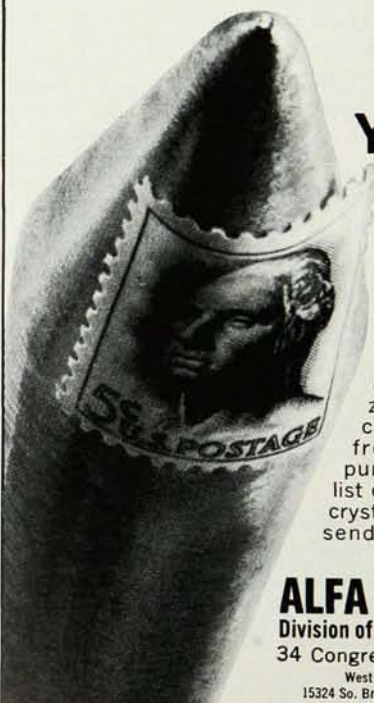


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to refer to the book, since even a hint of an idea that is useful could save much time and expense.

On the other hand, to use the book effectively one must already be fairly conversant with the theory involved, and with basic plasma diagnostics generally. It is not meant to teach this basic material.

At the size and price, this book is extremely cheap for the man who may need it; it is expensive for anyone else.

* * *

The reviewer has worked with plasmas, including the reentry sheath. He is presently studying the chemical reactions that may be induced by plasmas in some organic systems.

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