BOOK REVIEWS

The Theory of Neutral and Ionized Gases. University of Grenoble Summer School of Theoretical Physics (Les Houches, 1959). C. DeWitt and J. F. Detoeuf, eds. 469 pp. (Hermann, Paris) John Wiley & Sons, Inc., New York, 1960. $17.50.

Plasma Physics. Material Presented at Internat'l Summer Course (Risö, Denmark, Aug. 1960). C. F. Wandel, ed. 645 pp. Danish Atomic Energy Comm. Research Establishment Risö, Roskilde, Denmark, 1960. Paperbound Dan. kr. 60.00. *Reviewed by Rolf Landshoff, Lockheed Missiles and Space Division.*

BOTH of these volumes are the outcome of summer-school courses on plasma physics which have been conducted in Europe; one in 1959 at the University of Grenoble and the other in 1960 at the Research Establishment Risö of the Danish AEC. In both instances the organizers gathered outstanding authorities to present the courses. The two volumes offer very good introductions to the subject but from different points of view. The first one is quite academic in character; starting from basic principles, it works its way to the more common methods and only in the final chapter does it tackle an application. The Risö report is much more application-minded. It faces the problems encountered particularly in thermonuclear research in a rather more intuitive fashion and it places more emphasis on results than on methods and detailed mathematical proofs.

The behavior of a plasma can be explored from a microscopic or a macroscopic point of view, i.e., by carrying out a statistical analysis of particle behavior or by formulating the laws in terms of variables like pressure, temperature, etc. The statistical method is based on the principles introduced by Gibbs or on their quantum mechanical equivalent. After a brief formulation of these principles the first author of the Grenoble course, E. W. Montroll, describes the application of Feynman-diagram techniques to systems of interacting particles in equilibrium. The second author, L. Van Hove, turns to nonequilibrium problems and bases his exposition on the quantum-mechanical density matrix. He points out the significance of the so-called random phase assumption which leads to simpler formulations like the Pauli and the Boltzmann equations.

J. L. Delcroix takes the classical approach via distribution functions in many-particle space, which are then approximated by distribution functions describing single particles, particle pairs, etc. For this hierarchy of distribution functions he derives kinetic equations in which each member is linked to the next higher one. This procedure introduces a correlation between particles which depends on their distance in units of the Debye length. A particularly suitable approximation for the long-range but weak interactions in a plasma is the Fokker-Planck equation. Following its derivation, A. N. Kaufman describes its use for the calculation of transport coefficients. The macroscopic approach via the magnetohydrodynamic fluid model is followed up by M. Kruskal. By means of energy variational principles derived from the MHD equations, he investigates equilibrium configurations and their stability.

Small disturbances in a plasma can be Fourier analyzed into a large variety of waves differing in regard to the relative directions of propagation, of currents and, if present, of a superimposed magnetic field. The dispersion of these waves is considered in the course by J. F. Denisse. The final course of the series by E. Schatzman goes into the application of plasma theory to astrophysics, discussing the deviations from local thermodynamic equilibrium, various radiative processes, and both interstellar and stellar magnetic fields.

The course at Risö was conducted by twelve lecturers from five European countries and from the USA under the directorship of M. N. Rosenbluth. The manuscripts of their lectures which appear under 31 separate headings and reproductions of seven earlier papers by members of Project Matterhorn make up the second book. The main section headings are: Single Particle Motion, Magnetohydrodynamics, Fundamental Equations, Stability, Relaxation, Radiation, Thermonuclear Aspects, Pinch and Shock, Apparatus Concepts, and finally Plasma Waves and Diagnostics.

In lieu of a discussion of all lectures which would go beyond the endurance of reviewer and reader alike, let us pick one of the sections as a typical example. The prospect of achieving a fusion reactor depends critically on the eventual success in preventing or at least slowing down the disassembly of the plasma by instability. The relevant section on stability starts with a lecture by R. J. Bickerton and a series of reprints which deal with the MHD approach. This is followed by Rosenbluth's discussion of the microscopic approach which leads, for example, to the phenomenon of two-stream instability. In the next lecture R. F. Post examines instabilities caused by the anisotropy in velocity space, a phenomenon which is typical of the confinement in a mirror machine. The section concludes with a review in which W. B. Thompson systematically goes over all the available models for carrying out stability analyses, over the appropriate methods which go with these models and over the results. By writing this particular lecture in the style of an outline, Thompson has made it much simpler for the reader to find his way through the large amount of material which he covers.

The lectures in both volumes are of a uniformly high quality and the serious student can fill in some of

the mathematical detail that is lacking by following up the original articles which are referenced in a very thorough fashion. The Risö report fills a void which has existed for a long time.

Fast Reactor Cross Sections. A Study Leading to a 16 Group Set. By S. Yiftah, D. Okrent, P. A. Moldauer. Vol. 4 of Division 2, Nuclear Physics, in the Internat'l Series of Monographs on Nuclear Energy, J. V. Dunworth, gen. ed. 130 pp. Pergamon Press Ltd., Oxford, 1960. 35s. *Reviewed by Eugene P. Wigner, Princeton University.*

THIS is a short monograph but an interesting one. The fast reactors, with which it deals, are fission chain reactors in which the fission reaction is induced predominantly by fast neutrons, that is, neutrons of at least 100-kev energy. The authors attempt to calculate the nuclear characteristics (that is, the ability of the reactor to maintain a chain reaction) solely on the basis of fundamental data, such as fission cross sections, number of neutrons emitted per fission, elastic- and inelastic-scattering cross sections, etc. The measurements of these quantities were collected, critically reviewed, and tabulated for each of their 16 neutron-energy groups. The first of these groups comprises neutrons the energy of which exceeds 3.67 Mev (10/e Mev); the energy of the neutrons of the last group is between 0.5 and 2.1 kev ($10/e^{8.5}$ Mev). The calculation of the multiplication constants, danger coefficients, etc., is carried out by the so-called multigroup method, using as groups the 16 energy regions of the tabulation. The results of the calculation are compared with the critical properties of actual reactors (with exotic names such as Yezebel, Godiva, etc.) and subcritical assemblies. The disagreements, which are perhaps greater than optimists may have hoped, emphasize the significance of the comparison and also the gaps in our knowledge. These are also discussed in the booklet.

This small volume not only answers an intellectual challenge; it will also be useful for everyone interested in nuclear chain reactors. The results obtained should be useful also in the theory of thermal reactors inasmuch as they should make it possible to improve the calculation of the "fast effect", i.e., the contribution of the fast neutrons to the chain reaction.

Annual Review of Nuclear Science, Vol. 10. Edited by Emilio Segrè, Gerhart Friedlander, Walter E. Meyerhof. 617 pp. Annual Reviews, Inc., Palo Alto, Calif., 1960. $7.00. *Reviewed by D. Keefe, Lawrence Radiation Laboratory.*

EIGHTEEN articles on cosmic rays, nuclear physics (at all energies), radiobiology, and radiochemistry are offered in the tenth volume of the *Annual Review of Nuclear Science*. The editors continue their usual policy of presenting a collection of articles self-contained and up to date with the valuable characteristic that all can be easily read by the average nuclear scientist. This is a book you read not just for the reviews touching your own field but also to escape easily and profitably from your own compartment and find out what is new and interesting in other subjects.

F. Reines describes interactions of the neutrino—both the few which have been detected and the exciting ones predicted for the future. The history of the first twenty years of this Pimpernel particle has been reviewed many times but in recent years interest in its properties has been further aroused to the extent that new high-energy accelerators are being designed with this study in mind. Other aspects of high-energy physics are covered by H. Bradner who discusses the importance of bubble chambers, their design and construction, and the magnitude of the new data-processing problems posed, and by O. Chamberlain who summarizes the principles and design considerations underlying the construction of secondary particle beams at accelerators. In a group of three reviews on nucleon-nucleon scattering in the region up to 400 Mev, H. P. Stapp, M. H. MacGregor, and M. J. Moravcsik present a well-organized summary of the experimental situation in a field where several recent important advances have been made, and the corresponding theoretical analysis. They emphasize the phenomenological approach and the more satisfactory description in terms of dispersion theory, in contrast to some recent reviews on the same problem describing potential models and calculations based on meson theory.

A. Zucker treats the nuclear interactions of heavy ions from both the experimental and phenomenological points of view, and describes how scattering, transfer, compound-nucleus, and fission reactions may be analyzed. Certain complex nuclear reactions can only be studied by observing the angular and energy dependence of the recoiling heavy ion—the pertinent experimental techniques are discussed in B. G. Harvey's article on recoil techniques. The application of the shell model to the explanation of the energy levels of light nuclei, i.e., up to neon, is summarized by I. Talmi and I. Unna who discuss the theory of the single and many-particle states and go on to derive the energy levels; there is an extremely useful concomitant summary by Mrs. Selove and T. Lauritsen of the values of these energy levels, presented in diagrammatic form. E. L. Church and J. Weneser survey the present status of internal conversion and the information it can provide on nuclear structure, and consider the finite nuclear-charge, or static effect, the dynamical penetration effects, and in particular the important information to be derived from EO or monopole transitions.

In recent years very elaborate and costly experiments have been set up in several countries to attack the problems of extensive air showers in the atmosphere; apart from the cosmological problem there are several features of the atmospheric development process which are still baffling. K. Greisen recounts the latest information obtained in this field on the size and structure