

the mathematical detail that is lacking by following up the original articles which are referenced in a very thorough fashion. The Risø 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 character-

istic 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 Pimpnel 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