Book Reviews

Physics of Fast and Intermediate Reactors, Volume III: Proceedings of the Seminar on the Physics of Fast and Intermediate Reactors Sponsored by the International Atomic Energy Agency and Held in Vienna 3–11 August 1961. International Atomic Energy Agency, Vienna, 1962. 619 pp., $12.00.

This volume, which is the third of three covering the Seminar on the Physics of Fast and Intermediate Reactors, contains the formal papers on reactor dynamics and the physics of specific reactors, as well as the informal Proceedings of the entire seminar. English is used for the Proceedings as well as for eleven of the eighteen formal papers; the remaining papers are in French and Russian.

The papers on physics of specific reactors cover the fast reactor at Dounreay, EBR-II, the Russian fast reactor BR-5, the French fast reactor RAPSODIE, a Russian pulsed fast reactor, and an epithermal thorium reactor. The physics of the Enrico Fermi reactor, although not the subject of a formal paper, is covered at some length in the Proceedings. These discussions perform the specific function of characterizing the neutron physics behavior of the specific reactors, and the more general one of indicating what neutron physics considerations play important parts in the reactor designs. Moreover, since the calculated physics characteristics are usually related to experimental work, either on critical experiments or on the reactor in question, they give a reasonably good picture of the status of neutron physics theory for the relatively small fast reactors which are currently under construction or in operation. The physics of the larger, more dilute reactors, which perhaps has the greater significance for the future, is covered mainly in other volumes of this series.

The section on reactor dynamics gives a more integrated picture of the dynamic theory of fast reactors, and of its implications for reactor safety and reactor design, than one might expect to find in a collection of individual papers. This coherence is facilitated by review papers on reactor safety, and by the inclusion of some work, notably some of the experimental work with the TREAT facility, which goes beyond the boundaries of neutron physics. Considerable attention is given to the problem of power-dependent structural distortions, and to methods of determining the reactivity feedback which may result. The importance of these considerations has been emphasized by the instabilities encountered, some years ago, in the second core of EBR-I; this particular manifestation of the problem is treated, and shown to be rational, in a paper which is apparently the final word on the subject. Other papers and discussions treat Doppler, temperature, and coolant-void coefficients of reactivity, neutron lifetime, methods of dynamic analysis, and dynamic analyses of specific reactors. It is evident that, in the past few years, significant advances have been made in the understanding of fast reactor dynamics and safety; the latter remains, however, one of the crucial areas in the development and design of practical fast breeder reactors.

Several speakers at the seminar were careful to point out that most of the safety problems of fast reactors are not inherent results of the fast neutron spectrum, but rather are characteristic of the specific embodiments of the fast reactor principle which are currently under development. However, until some alternate economically promising concept of the fast breeder is proposed, this distinction is a rather academic one: the fact remains that in the current concept the fast breeder requires, and is getting, more careful safety attention than most other reactor types.

The informal Proceedings, which occupy some 180 pages of the volume, are of particular interest. It is clear from the discussions of dynamics and safety that there are still differences of opinion as to the soundest design approach to fast reactor safety.

Although this volume will be of particular interest to the reactor physicist, the portion which covers dynamics and safety is sufficiently general to interest all who are concerned with reactor design and performance, and especially those who are engaged in the design of fast neutron reactors.

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(About the Reviewer: Joseph R. Dietrich was awarded the Ph.D. in 1939 at the University of Virginia. He has worked in the field of power reactors since 1946, first at ORNL and later at Argonne. At Argonne he was in charge of theoretical and experimental reactor physics on the Nautilus prototype reactor and on the BORAX reactors, and between 1954 and 1956 supervised the reactor physics work there on fast reactors and other reactors. He joined the General Nuclear Engineering Corporation upon its formation in 1956, and is Vice President and Director of the Physics Department. He is also Editor of the Technical Progress Review, Power Reactor Technology *and is a Fellow of the American Nuclear Society.)*

Fast Reactors. By R. G. PALMER AND A. PLATT. Temple Press, London, 93 pp, 1961, $175.

Temple Press, in conjunction with the journal *Nuclear Engineering*, has prepared a large number of monographs on different subjects pertinent to the reactor field. In the publisher's note which prefaces "Fast Reactors," the scope of the monographs is said to be "...intended for university and technical college students, research assistants and qualified technicians...." "Fast Reactors" reaches this audience adequately and, in fact, can be a useful introduction for anyone in the reactor field who has had no previous

experience with either sodium-cooled reactors or with fast reactors.

The book is divided into six chapters, of which the first five are the best, since the sixth chapter delves into the problems of liquid metal heat transfer in what the reviewer feels to be an inappropriate extent.

Chapter 1 discusses the long-range value of fast reactors due to the breeding abilities of the type, and the discussion is limited to this particular advantage with no indication of other technical advantages which fast reactors may have for propulsion and other applications. In this chapter the basic technological problems common to all fast reactors are indicated, and brief summaries of the characteristics of the Dounreay fast reactor, the EBR-II, and the Enrico Fermi reactor are given to illustrate the contemporary solutions to these problems.

Chapter 2 discusses the general problem of materials in a fast reactor, and points out that in general no common structural materials are excludable a priori from fast reactors simply on the basis of their nuclear characteristics. There is a discussion of the present fast reactor fuel materials with a brief discussion of possibilities for the future. The grounds on which sodium or NaK have been selected for use as coolant in present fast reactors are stated concisely, together with some comments on canning and structural materials.

Chapter 3, headed "Sodium Technology," is a good summary of the engineering problems that are involved in the use of sodium as a coolant, although not at all unique to such use in a fast reactor. The methods for detection and control of impurities are mentioned, and the problems involved in pumping sodium, and in designing heat exchangers in which heat removed from the reactor is ultimately transferred to water, are described with the use of excellent sketches. The problems involved in providing bearings for operation in a sodium environment are mentioned, although some of the solutions given probably would not be considered adequate today.

Chapters 4 and 5 cover "Fast Reactor Statics" and "Fast Reactor Dynamics," and would in themselves be a useful introduction for one who had previous experience in thermal reactor physics and was interested in some semi-quantitative aspects of fast reactor physics. In an attempt to reach the audience which is the objective of this monograph, some extremely elementary concepts are developed, perhaps more fully than could have been the case, but in general the presentation is accurate and flows well. The discussion on reactivity feedback and the EBR-I stability investigations might well be too detailed for most of the technicians that the reviewer knows. This area is also somewhat out of date. Somewhere in these two chapters it would have been appropriate to have included a section on the safety problems that are unique to fast reactors, as this subject is only mentioned in a cursory way in Chapter 1.

The sixth chapter has far too much detail about liquid metal heat transfer and is not appropriate in depth to the rest of the material in the book.

All in all, "Fast Reactors" is an interesting monograph which should be useful to the audience which it seeks to reach, and of background interest to one seriously involved in design, even though many of the most troublesome engineering problems which have arisen in the design of fast reactors are not covered explicitly.

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(About the Reviewer: Mr. McCarthy is Assistant to the General Manager of Power Reactor Development Company, the organization which has built and is to operate the Enrico Fermi Atomic Power Plant near Detroit. Mr. McCarthy was for a number of years Head of the Nuclear and Analytical Division of Atomic Power Development Associates, Inc., and has been active in the fast reactor field since 1952.)

Principles of Cyclic Particle Accelerators, JOHN J. LIVINGOOD. Van Nostrand, Princeton, New Jersey. 392 pp., $10.75.

The author, Doctor John J. Livingood, is a recognized elder statesman of accelerator physics. His work on accelerators began in the early 1930's as a collaborator with E. O. Lawrance at the University of California where he participated in the early "great thrust forward" of the cyclotron. Following World War II he was associated with the Collins Radio Company and headed the group which constructed 60-in. cyclotrons for several U.S. institutions. In 1952 Doctor Livingood joined the Argonne National Laboratory where he headed the Zero Gradient Synchrotron (ZGS) project during its formative years.

"Principles of Cyclic Particle Accelerators" is an introduction to fundamental principles and major fabricational features of cyclic accelerators, i.e., cyclotrons, synchrocyclotrons, synchrotrons, betatrons, linacs, etc. It is a distinct pleasure to find a full account of the principles of this wide class of machines in a single volume; for the introductory reader this should be especially advantageous. Emphasis in the book is on conveying to the reader an understanding of phenomena rather than on rigorous mathematical development, and as a result the author nicely avoids getting bogged down in mathematical detail. (A mathematical background is assumed roughly equivalent to that of a good undergraduate degree in Physics or Engineering.) The careful reader will obtain from the book an understanding of essentially all of the basic phenomena of cyclic accelerators.

In a critical vein, the origin of the book as a set of introductory notes for new ZGS personnel is, unfortunately, still substantially discernable; the discussion and choice of examples at several points tend to overemphasize edge focusing machines. Noteworthy for its absence is the elegant canonical coordinate description of synchrotron oscillations. The chapter on "Quadrupole Lenses" would be considerably less confusing if definitions had been employed in more direct accord with the long established and highly functional traditions of thick lens optics.

The format of the book is excellent—the print is easy to read and the large number of figures and plates are reproduced with excellent clarity. Typographical and other mistakes have been reduced to a minimal level which is in pleasant contrast to many of today's scientific works, especially first editions.

Over-all, the book is an excellent introduction to the accelerator field and is highly recommended for persons seeking an initial acquaintance with the principals of these machines; it is particularly recommended to engineers and graduate students joining an accelerator project without previous experience in the field. The book is not intended