explained to a greater or lesser extent in no less than five different places in the book.

In spite of these defects, however, I think this book is well worth reading for anyone with a technical background who is looking for an introduction to the field of nuclear propulsion.

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Heavy Water Lattices. Compiled by H. D. BROWN. International Atomic Energy Agency, Vienna, 1960. 142 pp. $1.50.

This booklet serves as the proceedings of a panel convened by the International Atomic Energy Agency in September 1959 in Vienna on the lattice physics of heavy water reactors. Its chief value is as a record of that meeting, since its value as a status report has largely been diminished by time and since some of the technical material presented in a preliminary or fragmentary fashion has since been published more fully.

The book contains two sections—a Proceedings and an Appendix. The 24-page Proceedings section contains a very brief summary of the topics discussed during the week-long meeting. Program status reports were given by the panel members from Canada, France, Norway, Sweden, the United Kingdom, and the United States. These status reports indicate the degree of effort being made in heavy water reactor physics at that time. An interesting table summarizes estimates of the accuracy of buckling measurements that have been and are being performed, from which it was concluded that measurements made in the different laboratories agree within the probable errors.

The 102-page Appendix contains 16 supporting technical papers solicited from the panel members and their colleagues. These papers cover a wide variety of topics. Of greatest value are the papers bringing up to date the various procedures for correlating experimental buckling measurements that had been described at the 1958 Geneva Conference. These papers include a complete listing of the equations used in Sweden for lattice calculations, a previously unpublished correlation from Harwell, a list of corrections to previously published buckling measurements from Savannah River, and a French analysis of some Savannah River experimental results. As far as I know this information is not widely available elsewhere.

The most important experimental paper has since been published.* Among the other experimental papers are:

1. A list of buckling values obtained in the ZEBRA exponential facility in Sweden on fuel assemblies of UO_2 rod clusters (both with D_2O coolant and with the coolant passages empty),

2. Temperature coefficient measurements measured in ZEEP at Chalk River,

3. A ZEEP experiment on the effective cross section of Zircaloy-2,

4. Some preliminary results of ZEEP experiments in which the neutron flux inside several fuel pieces was measured with several different detectors to give an indication of the departure of the reactor spectra from dE/E, and

5. ZEEP measurements on the reactivity effect of removing coolant from lattices of multiple rods (published more fully in CRRP-942).

This paper-bound book was published promptly, the printing is excellent, the drawings are well reproduced, and there is only a minimum of typographical errors.

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Elements of Nuclear Engineering. By GLENN MURPHY. Wiley, New York, 1961. 213 pp.

Professor Murphy is Head of the Department of Nuclear Engineering at Iowa State University and also serves as senior engineer at the Ames Laboratory of the U. S. Atomic Energy Commission. He has served as Vice-President for the American Society of Engineering Education and is at present chairman of the Committee on Objective Criteria for Nuclear Education, a joint undertaking of the American Nuclear Society and the American Society of Engineering Education.

The objective of this book is "to present at the college senior level a survey of the field of nuclear engineering for the purpose of indicating its scope, potentialities and limitations." It "is not a text in nuclear physics, a treatise on reactor theory, or a handbook on industrial use of radioisotopes." It is "simply to help undergraduate students in engineering decide whether or not they wish to explore this exciting field."

The text material is divided into three sections. Section I, comprising the first 73 pages, covers an introductory chapter on the engineer and nuclear energy, nuclei and nuclear reactions, and radiation. In Section II, covering 77 pages, reactor theory and engineering considerations of nuclear power are treated. Section III contains 49 pages devoted to radiation detection, shielding, radiation effects, and industrial uses of radioisotopes.

It appears to me that this division does an injustice to the chemical engineering aspect of nuclear engineering. A closer look reveals that slightly less than two pages are devoted to the topics of fuel reprocessing and the control of radioactive wastes. At the risk of appearing to be a traitor to my own interests in the field, I am persuaded that the problems encountered in waste control and fuel reprocessing are at least as difficult and challenging as those of reactor physics, for example. Therefore, the two pages (comprising 1% of the total) devoted to fuel reprocessing and waste

* E. HELLSTRAND, T. BLOMBERG, AND S. HORNER, The temperature coefficient of the resonance integral for uranium metal and oxide. *Nuclear Sci. and Eng.* **8**, 497–506 (1960).

disposal seem inadequate coverage even in a survey such as this.

In several places there appears to be some confusion on fusion. For example, on page 2, the footnote defines fusion as the joining of light nuclei to form a single heavy nucleus. A better choice of words would be "heavier" rather than "heavy." Again, in Figures 1.2 and 1.4, "fusion" is used where "fission" is intended.

In reviewing the general features of power reactor design, the Experimental Breeder Reactor is extensively cited. Thus, in Chapter V six out of eight of the illustrations are of the EBR, while two show features of the Experimental Boiling Water Reactor. Perhaps a better approach to the general features of power reactors might be to describe other designs such as pressurized water, sodium-graphite, organic-moderated, heavy water moderated, and gas-cooled systems.

The treatment of reactor theory in Chapter IV is limited to the modified one-group model of homogeneous, bare, thermal reactors.

One notes with gratitude the treatment in Chapter VIII on industrial uses of radioisotopes. This material should prove useful to the persistent questions of many students and others, "What is the immediate value of atomic energy?" Again, the inclusion of the well-known Chart of the Nuclides (Fifth Edition, revised April 1956) is a welcome addition.

Professor Murphy's long experience in education is evident from the very readable style of this book. Also, the publishers are to be commended for the good quality of paper and printing and the generally pleasing format.

In summary, this book will undoubtedly find use as an introductory survey to the field of nuclear engineering. For the undergraduate engineer who definitely wishes to specialize in nuclear engineering, some other text might be preferable to Professor Murphy's.

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Thermal Reactor Theory. By A. D. Galanin, 2nd edition. Translated by J. B. Sykes, Pergamon Press, New York, 1960. xiv + 412 pp. $15.00.

A. D. Galanin's *Thermal Reactor Theory*, which has now appeared in a second revised edition, remains one of the best books on the theory of neutron chain reactors. Professor Galanin, whose work in reactor theory first came to Western attention at the 1955 Geneva Conference, is a member of A. I. Alikhanov's Institute of Theoretical and Experimental Physics in Moscow and is known for his contributions to field theory as well as to reactor physics. His reputation as one of the ablest Soviet reactor theorists is borne out by this excellent book.

Thermal Reactor Theory is described in the Preface as a "guide to nuclear reactor calculations concerning neutrons." It therefore confines itself almost entirely to those parts of diffusion and transport theory which are needed for calculating neutron distributions in thermal neutron chain reactors. Within this somewhat restricted field Galanin does a fine, workmanlike job. There is a no-nonsense, direct quality to the book; Galanin never indulges in long windups before he pitches. He writes almost as though he were impatient to get to the point of his argument, and he always does get to the point (a trait not universally exhibited by writers of scientific books).

The book may be described as a high-powered version of Glasstone and Edlund. As such it covers much the same territory, but in a more penetrating and sophisticated manner. Galanin begins with a long chapter which treats in standard, but thorough, fashion diffusion and slowing down of neutrons. Here, as in the rest of the book, he states the limitations of the theory in physical, rather than formal, terms. He peppers his exposition with useful "fist" formulas which show that the author has had a practical and firsthand contact with his material. Thus even the experienced reader will glean vignettes in ground that is usually considered to be well-tilled; for example, I did not know, until I read Galanin, that there is a simple formula for ξ, $1/\xi = \frac{1}{2} A + \frac{1}{3} + (1/18A)$, which is good to 1%. Other such special tricks of the trade are found throughout the book.

The second chapter entitled "The Critical Size of a Reactor on One-Group Theory" again is standard, but with clever tricks. For example, by introducing an effective diffusion coefficient, $D_{eff} = D(1 + k\tau/L^2)$, Galanin is able to write the one-group reactor equation as $D_{eff}\,\Delta\Phi + (k - 1)\Sigma_a\Phi = 0$ and retain some of the effect of slowing down in a one-group formulation.

The book continues with a chapter on "Multiplication, Slowing-Down, and Diffusion in a Homogeneous Medium." The treatment is based largely on diffusion theory, and here the two-group equations are first introduced. The criteria for applicability of two-group theory are carefully examined. The extension to n-group theory is accompanied by the admonition that decreasing the group width below the distance a neutron can jump in a single collision makes no sense.

Chapter IV on the theory of heterogeneous reactors follows the U. S. procedures except for the part on resonance absorption. Here the method of I. I. Gurevich and I. Ya. Pomeranchuk is followed almost exclusively. The old Wigner method is mentioned and numerical results are quoted, but no attempt is made to clarify the relation between the two points of view. (Galanin's book appeared in Russian in 1958, just as the reactor community at large began to fully understand the relation between the Gurevich-Pomeranchuk formula and the Wigner formula.)

Galanin's discussion in Chapter V of critical size by two-group methods is elegant. After outlining the standard procedure, Galanin points out that one can compute once and for all in a simple plane case the modification in the boundary conditions—i.e., the extrapolation length—caused by the transient solution. With this extrapolation length one can reduce the two-group problem to a one-group problem with modified boundary conditions in much the same spirit as one modifies diffusion theory by imposing boundary conditions calculated from transport theory. The bulk of the chapter, as indeed of the book, is dominated by the viewpoint of the precomputing machine era of reactor