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 theory. However, there is an addendum to Chapter V on "Numerical Calculations of Critical Size" written by A. S. Kronrod and G. M. Adel'son-Vel'skii which should satisfy at least the less extreme of the computer-oriented reactor people.

The next three chapters, "Perturbation Theory," "The Time Variation in the Isotopic Composition of Nuclear Fuel," and "Delayed-Neutron Kinetics, the Temperature Coefficient, and Control," cover quite standard material. I particularly enjoyed the discussion of fission product poisoning; Galanin goes farther into this subject, as it applies to thermal reactors, than do most other books.

The last two chapters, "The Use of the Boltzmann Equation" and "The Theory of Heterogeneous Reactors," make heavier demands on the reader's mathematics. The discussion of the spherical harmonics method is practical, with a minimum of subscripts and a maximum of actual numerical equations. It was good to see Placzek and LeCaine's elegant variational method in transport theory restored to its rightful, useful place. There is a detailed discussion of neutron thermalization written in collaboration with R. G. Avalov.

The final chapter on the theory of heterogeneous reactors deals with the part of the theory to which the most thorough contributions have come from Soviet authors. Galanin pretty well follows the method of Feinberg, and concludes by computing the boundary conditions at a reflector around a heterogeneous reactor.

Galanin's book is distinguished by its pointedness, and consequent great usefulness, and by the obvious expertness of the writer. Galanin is a *responsible* author; each paragraph he writes has a purpose, each mathematical argument ends with a result which has a clear connection with something either practical or theoretical. Too many writers nowadays seem to write with neither beginning nor end—they savor words without feeling responsible for coming to a clear conclusion. Not so Galanin—he is expert, he knows what he wants to say, and he says it, usually succinctly and to good final effect.

But it is this directness, and attention to the main line, which is also a source of criticism of the book. Thus nuclear physics, certain parts of which are essential to a full understanding of reactor theory, is relegated to an unadorned appendix which is hardly a substitute for a discussion of the nuclear physics of thermal reactors. A second criticism is that, because of its succinctness, the author has little room for "cheap wisdom"—those somewhat philosophic insights into a subtle physical or mathematical point which answer the gnawing questions of the alert student, or show the connection between the theory at hand and other parts of physics, or qualify the accuracy claimed for an experimental result. In a book such as Galanin's, which has some of the tone of a handbook of criticality calculation, most readers will not be disappointed by these omissions: *Thermal Reactor Theory* more than makes up for them by its accuracy, attention to detail, and authority. It is a welcome antidote to the many sloppily written books in this field, and it will undoubtedly be used widely in the West as well as in the U.S.S.R.

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Basic Principles of Fission Reactors. By W. R. Harper. Interscience, New York, 1961. 314 pp. $7.50.

This book is not worth reading; in fact, a student could be easily misled by erroneous and misleading statements. The author is obviously unqualified. I could not force myself to read thoroughly beyond the first 76 pages.

To give proper perspective to the comments I am about to make, following is the first paragraph of the Preface:

"This book takes the reader to about the stage at which detailed reactor design begins, without assuming any previous knowledge of nuclear technology. It does, however, assume an appropriate background of physics and mathematics (and some chemistry). Though intended as an introduction to a post-graduate course, it should not be too advanced for the young student well prepared to proceed to a higher education in science or engineering, and it also provides a coherent account of reactors for those professionally qualified in neighboring fields."

Keeping this intent in mind, it is pointed out that the author completely neglects to mention a neutron spectrum or energy distribution (although he does mention the fission spectrum) and nowhere does he discuss the fact that cross sections must be averaged over such distributions. Further, I quote the only paragraph discussing resonance escape probability:

"The calculation of p is a much more complicated matter, as is evident from Figure 9.5 which shows the resonances in uranium-238. The probability of absorption as a neutron slows down past a peak will depend on how long the neutron remains within the energy range corresponding to the breadth of the peak, and this involves the distribution in energy of the neutron population that is undergoing slowing down. This must be calculated, and then applied to the computation of the resonance escape probability."

On a less theoretical level, except when discussing the history of the West Stands reactor, he gives no indication that UO_2 is a practical fuel material.

If this book were directed at the nontechnical audience, such glaring omissions may be acceptable. However, even for this audience, the book is harmful because of serious errors and misconceptions. As examples, I quote the following erroneous or misleading statements:

Speaking of the Periodic Table,

"The plot comes to a sudden stop at uranium, atomic number 92. Heavier nuclides are relatively short-lived, whatever the proportion of neutrons to protons. A number of them are now well known, having been made in the laboratory or in reactors, but there seems little hope of extendng the series much beyond atomic number 100."

Speaking of $E = mc^2$,

"It may seem strange that the velocity of light is involved in the equivalence of mass and energy, but we can easily see that this must be so, at least for the case of energy in the form of electromagnetic radiation. We choose to consider this particular case because, when electromagnetic radiation of whatever wavelength—radio waves, heat