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 waves, light, x-rays or gamma rays—is absorbed, its energy appears as heat, leaving nothing behind."

Other misleading statements are:

"Helium would be a good moderator if pressurized, but has not yet been used."

"Relatively little has been published about the technology of fuel elements, but one design has been described in detail."

"Both [West Stands and Calder Hall] had to utilize natural uranium, which, as we have remarked, is basic to all nuclear energy programmes depending on fission."

"The neutrons and gamma rays which escape from the core carry quite a lot of heat with them which is wasted. . . ."

"We see that oxygen and carbon are the only two freely available elements that can be incorporated in a reactor core while keeping neutron wastage to a minimum."

"The latter [leakage] is very important because neutrons go through solid matter like water through a sieve."

"The dimensions of the array are so chosen that a (fast) fission neutron from ^{235}U has a good chance of escaping from the rod in which it is liberated before being captured by ^{238}U: the rods must not be too thick."

"The smallest unit of length used by the engineer is a microinch,"

With these quotations, I leave you to your own conclusions.

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Elementary Nuclear Physics. By W. K. MANSFIELD. Temple Press, London, 1959. 60 pp., 38 illustrations $1.75.

The book is one of a monograph series in Nuclear Engineering designed for undergraduate college students. Although limited to the aspects of nuclear physics of utility in the nuclear reactor field, the selection of material is good. The major sections deal with basic ideas of atoms and nuclei, radioactivity, neutron reactions, radiation attenuation, and particle detection. In order to compress a large amount of information in a few pages, the author restricted himself to factual statements, with little explanatory material. One often wonders how well a student having only one year of college physics, primarily classical in nature, is able to assimilate condensed versions of nuclear physics.

With its admitted goal of producing an inexpensive volume, the publisher has employed many rough or qualitative graphs. For example, the Maxwellian speed distribution curve does not identify the value of the most probable speed; no indication is given of voltages in the geiger counter characteristics. The lack of grid work prevents a student from picking off corresponding numbers with any accuracy. Also, some of the diagrams are hard to understand, even if the reader knows the subject matter, for example, neutron absorption Fig. 21, and the neutron chain reaction Fig. 24.

As for emphasis, the author would have done well to place the magnitude of the energy release from fission and fusion in context with energy from common fuels. Similarly, a fine opportunity to summarize the roles of hydrogen, lead, and boron in a reactor shield was missed.

For the reader who cannot or does not wish to invest enough to obtain a more thorough background in nuclear physics, the book is useful.

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Materials for Nuclear Engineers. Edited by A. B. MCINTOSH AND T. J. HEAL. Interscience, New York, 1960. 373 pp. $11.85.

This book is a collection of articles on some possible reactor materials, namely: uranium, plutonium, thorium, uranium dioxide, uranium mono-carbide, uranium silicides, thorium oxide, graphite, magnesium, beryllium, and zirconium.

Dr. McIntosh, Development Director of the United Kingdom Atomic Energy Authority Production Group, has understandably chosen all authors from the UKAEA and these authors have understandably stressed materials and information of particular interest to the British reactors. Thus, there are almost as many pages on magnesium as there are on uranium, while there are none at all on beryllium oxide, nor in fact any on ceramic fuels diluted with ceramics or metals.

Most sections contain information on occurrence, extraction, preparation, physical properties, mechanical properties, creep properties, nuclear properties, compatibility, fabrication, and effect of reactor conditions on the material in question. There are numerous tables and curves which collect information in a readily visible and useable form.

There are some tantalizing lacks of information. For example, the editor says "only properly planned irradiation experiments can provide reliable data", but there is no suggestion throughout the book on how to properly plan such experiments.

There are relatively few misprints. These include some careless ones. On page 81 it states that PuO_2 is obtained by heating Pu metal in ammonia. On page 177 there is a confusion between temperature and density in the text and caption of the figure. On page 216 the half-life of C^{14} is given as 10^3 yr while actually it is about six and one-half times this long. On page 273 ammonium fluoride is written instead of beryllium fluoride. On page 305 it is stated that there is no evidence for a beryllium hydride. Actually there are a number of articles in the literature on this material.[1]

[1] See for example: *J. Am. Chem. Soc.* **79,** 3687–89 (1957).