Messiah, Gottfried, or Schiff. For instance, the introductory chapter presents the result that

$$\frac{d\sigma}{d\Omega} = |f(\Theta)|^2$$

is the differential cross section by writing the time-independent Schrödinger equation and stating the asymptotic solution. Such a cursory treatment is not likely to be meaningful to undergraduates.

A reasonably strong background in nuclear physics is also required. The results of shell model calculations are presented with little discussion and many of the equations appropriate for the collective model are given with inadequate explanation for a first time exposure. The level of difficulty is fairly uniform throughout and would be tough going for most students before their second year of graduate study.

The author is to be commended for the careful organization and logical development of concepts. For example, the first Born approximation is presented as a special case of the Born series for the scattered wave function. Such a treatment is certainly more satisfying than the somewhat contrived introductions in elementary texts, even though the formal presentation is probably inappropriate for beginners. The Coulomb potential solutions are developed in parallel to the shorter range approximations rather than as an unrelated problem.

The chapter on scattering theory is well done but, again, it is necessary to have reasonable facility with such things as Clebsch-Gordon coefficients and scattering matrices.

The chapter of greatest interest to readers of this journal is apt to be Chap. 6 entitled "The Compound Nucleus." Lucid explanations are given of the Breit-Wigner formulas for both reactions and elastic scattering. Successes and failures of the model are clearly stated.

Chapters in the book, other than those already alluded to on nuclear models, scattering theory, and the compound nucleus, include electromagnetic interactions, the optical model, direct inelastic scattering, strong absorption, transfer and knock-out reactions, and high-energy nuclear reactions.

The book has occasional misprints but these should not create too much confusion. The index is more than adequate with a number of cross references. The references to texts are too vague to be very useful, since neither chapter nor page numbers are given. References to journals, particularly in the chapter on high energy reactions, are adequate and up to date. No problems are included, which decreases the book's utility as a text.

In summary, the book's strong points are its logical organization and succinct statement. Important topics are treated in sufficient depth for more advanced students, but not in sufficient detail for the beginner. The primary audience will be medium energy physicists rather than those whose interests are neutron or low energy nuclear physics. There is probably no new material of interest to nuclear engineers.

E. L. Draper, Jr. is an assistant professor of mechanical engineering and associate director of the Nuclear Reactor Laboratory at the University of Texas at Austin. He received BA and BSChE degrees from Rice University and a PhD in nuclear science and engineering from Cornell University. His interests include neutron physics, nuclear power engineering, and applied nuclear physics.

Title Advances in Nuclear Science and Technology, Volume 5

Editors Ernest J. Henley and Jeffery Lewins

Publisher Academic Press, Inc., 1970

Pages xv - 379

Price $21.00

Reviewer Stephen J. Gage

Volume Five in the *Advances in Nuclear Science and Technology* series is a collection of six articles reviewing recent developments in the theory and practice of nuclear engineering. These articles cover various topics ranging from the academic to technological detail.

There are three excellent reviews of theoretical and calculational developments which continue the first-rate contribution of this series in these areas. "Stability Analysis of Nonlinear Space Dependent Reactor Kinetics" by W. E. Kastenberg certainly measures up to expectations and will be of interest to researchers both in and out of the nuclear field. S. Kaplan's delightful yet scholarly work, "Variational Methods in Nuclear Engineering," is his second outstanding contribution to the series, the first being "Synthesis Methods in Reactor Analysis" in Volume Three. His perspective and lucidity in developing and integrating the various approaches is to be highly commended. To be utterly picayune, the article was marred slightly by several awkward sentences but this should not diminish its appeal to students, both old and new.

"Methods and Data for Reactor Shield Calculations" by F. H. Clark is another fine contribution to the series. This article is indeed a true survey; it provides a comprehensive view; it "oversees." It does demand that one "have some acquaintance with shield calculation methods" and yet it can be very helpful to the intermediate-level graduate student or to the worker who is refreshing or expanding his knowledge of shielding methodology. I found several things with which to trifle: the treatment of discrete ordinates and multigroup calculations is much too abbreviated; topics like gamma-ray buildup factors and albedos are treated in too much detail in comparison to other equally important subjects; and there are proofreading errors. But it remains an eminently useful survey.

The fourth theoretical paper appears out of place; it is of a different genre. "A Round-Off Free Solution of the Boltzmann Transport Equation in Slab Geometry" by L. Lois and J. Certaine basically describes "a new analytic solution so formulated as to be free to round-off". There is only an exceedingly brief survey of classical analytical solutions of the Boltzmann equation, followed largely by an exposition of the round-off free solution to the Boltzmann equation for a variety of cases. While the material is presented very clearly and interestingly and while it may be of interest to a number of researchers, I felt that the work was not quite in keeping with the other reviews. This article, albeit somewhat abbreviated, would appear more at home in *Nuclear Science and Engineering.*

On the technology side, there are two reviews which illustrate all too well some of the hazards in attempting to pin down, as one would a butterfly, a technology which is in such a state of agitation.

In "Nuclear Power Systems for Space Applications." B. Lubarsky attempts and nearly succeeds in elucidating an understandable view of that technology. He promises that "this is an introduction to nuclear power systems, intended for people unfamiliar with the field" but succumbs to the temptation to clutter an otherwise excellent review with too much detail. Much of the article was written very well with an economy of style but it would have been strengthened considerably, in my opinion, by a radical condensation of the excessively long sections on Advanced Reactor Systems and Other Systems.

An alternative approach would have been an orderly treatment of the various nuclear thermal sources and energy conversion methods and then a few examples of nuclear space power systems which have been studied or developed. But we are too close to our turbulent past to be able to unravel it clearly for the outsider. Histories will be written of the NASA-AEC liaison and of the many beautiful devices in search of missions but I assumed that this was certainly not Lubarsky's aim. The article, complicated as it is by the SNAP point of view, will be of interest to engineering students, who will surely wonder at its organization, and practicing scientists and engineers, who may find in its detail suggestions of important work to be done in the energy conversion field. In summary, it is the best, most useful survey of nuclear space power systems that I have seen but undoubtedly tomorrow will offer more coherent efforts.

History has also had its effect on the other technology review article, "Objectives and Design of the Fast Flux Test Facility," by E. R. Astley, L. M. Finch, and P. L. Hoffman. The transfer of the prime contract on the FFTF from Battelle Northwest to Westinghouse in early 1970 did receive, of course, widespread coverage in the press. Although the AEC's commitment to the FFTF appears to be unwavering, the relationship of the FFTF to the one to three 300-500 MW(e) demonstration LMFBR's which are to be built has not yet been fully resolved. One effect of the increasing concern over funding and scheduling of the LMFBR demonstration reactors has been a redesign of the core configuration to make the FTR core prototypical of the demonstration reactors. Thus, the novel and desirable features that "provide good accessibility to the reactor, permit core instrumentation, and ease the problems of using numerous control drive mechanisms" of a dispersed, conical, split-core arrangement have been sacrificed in order to obtain more useful power reactor operations data from the FTR. Consequently, the sections on Nuclear Design of the Split-Core Reference Concept and FTR Mechanical Design Aspects are no longer applicable. A succinct description of the present version of the FTR core appeared in an article by W. E. Roake and J. C. Tobin, *Nuclear News*, March 1970.

"The reactor FTR has a vertical core of hexagonal fuel assemblies, open test positions, closed loop positions, and control assembly channels. The 217-pin mixed oxide driver fuel assembly is contained in a stainless steel duct. The vertical core contains provisions for six closed loops, isolated from the reactor coolant, and several fully instrumented open test positions. The core is cooled by flowing sodium entering from a lower plenum."

Details of the present core design can be found in "Establishment of the FFTF Vertical Core Reference Concept," compiled by C. A. Cabell, BNWL-1165, September 1970. This report will presumably be available through the Clearinghouse. I have dwelt on this subject because I have found it very difficult to obtain up-to-date technical material for lectures on the LMFBR program to our graduate classes or to interested technical groups.

Returning to the article, the material describing FFTF design objectives and driver fuel choice remains valid by and large and should be of considerable general interest. The comparisons of the uranium and plutonium oxides and cermets will be quite valuable to nuclear engineering faculty and graduate students although serious workers in the field will have to turn to the project reports for adequate detail. The article was well-written so it is unfortunate that the book was not bound in loose-leaf form so that appropriately revised sections could be sent to all purchasers of the book.

This volume in the series is technically well done. Its organization and format contribute greatly to its readability. As indicated above, I think its major contributions are the three excellent reviews by Kastenberg, Kaplan, and Clark. The major shortcoming is due primarily to the ineluctable pressure of history on men and events. The theoretical underpinnings of nuclear energy are secure now. If the raging storm would only subside, then the technology could be advanced in a more orderly and realistic fashion.

Stephen J. Gage, associate professor at the University of Texas at Austin, received his BS degree in mechanical engineering from the University of Nebraska and his MS and PhD in nuclear engineering from Purdue University. He joined the faculty of the Nuclear Engineering Program, Department of Mechanical Engineering, The University of Texas at Austin in 1965. As coordinator of the Nuclear Engineering Program he has developed a graduate program in nuclear engineering studies. In 1966 he was appointed Director of the Nuclear Reactor Laboratory and has supervised the upgrading of the University's TRIGA reactor and the development of an active irradiation and analytical services program. He has served as chairman of the Technical Advisory Committee for the Southern Interstate Nuclear Board for the past three years. He has also served, on a part-time basis, with the Illinois Board of Higher Education as the Conference Director of the Midwest regional conference on "Science, Technology, and State Government: Achieving Environmental Quality in a Developing Economy." This conference sponsored by NSF and HEW was held in Chicago on November 17-19, 1970. Gage is a member of numerous honorary and professional scientific and engineering organizations. He is also a member of the Editorial Advisory Board of Nuclear Technology.