# Book Reviews

**Annual Review of Nuclear Science.** Edited by E. Segrè. Annual Reviews, Inc., Palo Alto, California (1970). Vol. 20. 588 pp. $10.00.

The National Research Council's Committee on Nuclear Science is probably the most venerable of those still active in the field. Its beginnings go back to the days when radium standards could occupy the center of committee attention. World War II marked a discontinuity in its efforts, at a time when the area of nuclear science (to continue the mathematical metaphor) was exhibiting a singularity. In the post-war reorganization the Committee felt that one of the ways they could assist a return to the normal development of nuclear science was by sponsoring an annual collection of review papers covering all scientific disciplines involved with the atomic nucleus in some way. An appropriate publisher was found in Annual Reviews, Inc., a non-profit organization which had been issuing similar reviews in the chemical and biological sciences since 1932. The entire membership of the Committee on Nuclear Science participated to some degree in the editorial chores for that first volume which appeared in 1952. The title page stated that it was "published by Annual Reviews, Inc. in cooperation with the National Research Council." Succeeding volumes carried the same statement, but direct involvement of the NRC became less and less (by intention) as responsibility passed to an outside group of distinguished and highly competent editors. E. Segrè's name appeared on the Editorial Committee from Vol. 2 on. With Vol. 8 he became chief editor, a position he has filled with great distinction ever since. In 1960, with Vol. 10 (there had been two volumes in 1953), any trace of the connection with the NRC was quietly dropped. By then the Annual Reviews of Nuclear Science had made such a name for itself that it could well stand on its own.

The present volume lives up to the standards of its predecessors. The series has always been catholic in scope, embracing applications of nuclear science in a wide range of disciplines both inside and outside the physical sciences. Volume 20 contains 13 articles covering such disparate topics as the quark model (G. Morpurgo) and the interaction of molecular structure with apparent nuclear properties (J. M. Hollander and D. A. Shirley). Exceptionally, there are no articles related to the earth sciences or the biological sciences. Even so, it would be impudent presumption on the part of any reviewer to try to comment knowledgably on all the articles. In the present volume there are, however, four articles that are sure to be of interest to a goodly fraction of the readers of *Nuclear Science and Engineering*, and these call for at least brief mention.

The lead-off article by H. T. Motz of Los Alamos Scientific Laboratory is on neutron capture gamma-ray spectroscopy. In a brief 28 pages of text Motz threads his way at breakneck speed, but with authoritative expertise, through almost all aspects of the field, from experimental techniques to nuclear level theory to expected future developments. The breathless pace is the obvious drawback. Probably the article will be of most value to those already reasonably familiar with the field who can consider the text as an organized guide to the formidable bibliography (452 items on 11 closely printed pages).

Brevity is also the mark of B. C. Diven's article (26 pages including references) on the fascinating technique of using nuclear explosions for making nuclear measurements. (This is likely to be the only successful peaceful application of nuclear explosives.) Much of the article is concerned with the special measurement techniques required for experiments which are all over in a few milliseconds. Especially valuable is the summary listing of the kinds of measurements performed at each of the four experiments performed through the Physics 8 experiment in 1969. Within the brief compass of the article it was impossible to discuss any of the results obtained with these experiments. It is therefore especially regrettable that the bibliography did not list more extensively the report literature describing the actual data obtained. The references cited are mainly 1968 or earlier. Incidentally, the interested reader should also turn to a somewhat more popular presentation of the same topic by A. Hemmendinger in the November-December 1970 issue of the *American Scientist*. Hemmendinger was able to take advantage of the magazine's glossy pages to use many photographs for illustrations, including a striking color photograph on the cover.

Likely to be of particular interest for readers of *Nuclear Science and Engineering* is the article on the past and present of fast breeder reactors by W. Haefele and three colleagues from Karlsruhe. The emphasis is on reactor physics—particularly the fast-Doppler effect, sodium void coefficients, and cross-section uncertainties. But considerable attention is also paid to the desirable characteristics of fuel elements and the materials suitable for them. To judge from the discussion on cross sections, both experimental and evaluated, there is probably a light sprinkling of minor inaccuracies throughout the article. But the breadth of the topics covered makes this inevitable. Equally unavoidable is some degree of obsolescence (probably nine months to a year's worth) in the discussions on projects planned or underway. Nonetheless, the article is the best available summary of where we are in the fast breeder field and is especially valuable for its coverage of European developments.

By far the longest of the articles to be mentioned (and indeed in the entire volume) is the concluding one by R. F. Post on "Controlled Fusion Research and High Temperature Plasmas." It covers some 80 pages including a 76-item bibliography. Even if you aren't inter-

ested in the latest exciting developments on yin-yang coils, stellarators, and, of course, tokamaks, I strongly urge you to read the introductory few pages and the last section entitled "The Next Ten Years—And Beyond." The author, whose distinguished credentials are familiar to all, breathes here a spirit of fiery optimism. The tone may best be conveyed by quoting a single sentence—"Given a source of energy that is abundant, economical, and nonpolluting, mankind need have no fear of the future—without it he must again become Markham's 'Man With The Hoe'." For the veterans of nuclear fission technology—weary, bloody, and often bowed—it has a familiar 1945-ish ring. The temptation is great to shake our grey locks and warn that the fusion enthusiasts have a lot to learn. We might point out that the technology for molten lithium is at present mostly hypothetical and that there are likely to be massive engineering problems in operating cryogenic superconducting magnets in close proximity to such intense sources of radiant energy. We could suggest that a 5000 MW D-T fusion reactor, with its huge tritium inventory and tremendous leakage of penetrating 14 MeV neutrons, could hardly be described as nonpolluting or hazard free. But who knows—maybe Post is right after all. Now all we have to do is convince the U.S. Congress, the American public, and J. W. Gofman.

This reviewer has several times gone on record deploring the usual collected volume of review or survey papers. Even when the articles are of high quality (all too rare) the topics may be so specialized that any one reader is usually interested in only one or two of the papers. The high cost of these volumes then in effect bars him from making suitable use of those particular papers of value to him. It is only proper to note therefore that the *Annual Review of Nuclear Science* goes a long way to meeting these objections. The authors have always been distinguished in their specialties and the articles are therefore most often of corresponding high quality within the limitations of the format. The price of each volume is reasonable, certainly by today's standards, and bona fide students can obtain a further discount of 20%. And this year, arrangements were instituted to provide reprints of individual papers for $1.00 each. The *Annual Review of Nuclear Science* deserves a salute from the scientific community it serves. Long may it flourish!

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*About the Reviewer: Dr. Goldstein, professor of nuclear engineering, Columbia University, returns to the Book Review section of* Nuclear Science and Engineering *with his usual forthright style. As author, teacher, and investigator, he needs no introduction to the nuclear community.*

**Nuclear Reactor Theory.** By George I. Bell and Samuel Glasstone. Van Nostrand Reinhold Company (1970). 610 pp. $24.50.

Since its title promises nothing very unusual, it is easy to assume that this book is just another introduction to reactor physics. Therefore, I think it important to point out very quickly that *Nuclear Reactor Theory* is quite different from any other book already on the market. It is, in fact, not a primer on reactor theory but a comprehensive exposition of reactor physics at an intermediate level, addressed to readers already familiar with fundamental principles. This group of readers has been somewhat neglected in the past.

But the level of presentation in this book is not its only novel feature. It seems to me that the authors have given us, here, the first combined and integrated treatment of reactor physics and practical reactor computational methods. Their emphasis is definitely on physics, not on numerical analysis or applied mathematics; still, Bell and Glasstone's extensive coverage of computer codes and reactor computations, generally, is excellent as an introduction and is very valuable, even to the specialist, as a guide to the technical literature. From this book the reader can get a fairly realistic picture of the work of the reactor physicist in a typical laboratory environment dominated by huge computers. Only a nicely blended presentation of reactor physics and reactor computational methods can give such a clear and realistic picture.

Unfortunately, it is difficult to combine so much material into a single volume, even one as large as this. It is not surprising, then, that in some areas the presentation is rather skimpy. For example, Bell and Glasstone deal with Monte Carlo in only three pages. For readers totally unfamiliar with the Monte Carlo method these pages will be helpful; others will find this rudimentary treatment disappointing. More typical, however, is the patient and skillful development of other computational methods such as, for example, the $P_N$ and $S_N$ methods.

Bell and Glasstone start their book with careful derivations of the integral and differential transport equations in various geometrics. Important properties of the one-speed transport equation, and important solution techniques are discussed extensively in Chap. 2. Here the infinite-medium Green's function is derived twice, once by Fourier transform methods and once by Case's method. The use of Case's method at this point is a typical Bell and Glasstone innovation, typical in that Bell and Glasstone have consistently avoided blind acceptance of traditional modes of exposition. Throughout their book one sees the influence of recent developments and new ideas. Of course, the Bell and Glasstone treatment of Case's method is very elementary. Mathematical difficulties are quickly set aside, but what remains is still a clear first glimpse of Case's method in its simplest form.

In this second chapter, also, the authors formulate the slab $P_N$ equations, and perhaps a comment on their derivation is in order. They say, on p. 87, that the spurious source required to convert the transport equation into $P_N$ equations is equal to $(N + 1)\phi'_{N+1} P_N/4\pi$. In Weinberg and Wigner (p. 266) one finds, instead, the expression $(N + 1)\phi'_N P_{N+1}/4\pi$. To the reader who stumbles onto it, this discrepancy may prove confusing. Actually, both sources yield the same $\phi'_n$s for $0 \leq n \leq N$. The latter source is so devised, however, as to guarantee that $\phi_n = 0$ for $n > N$. For this reason it is usually used in theoretical work on $P_N$ methods; it is this latter source, rather than the source defined by Bell and Glasstone, that the reader will usually see elsewhere.

$P_N$ equations are discussed more fully in Chap. 3 where, also, the double $P_N$ equations are first introduced. The authors say something here about computational methods, but not as much as I would like. The algorithm used to solve one-dimensional diffusion equations is of fundamental importance in reactor computations. I think, therefore, that this algorithm merits more consideration than Bell and Glasstone chose to give it.