where it is quite involved but not accurate enough to lend confidence in the answer to a practical problem. A reader, trying to follow this development is exhausted by the series of increasingly complex stages and frustrated by the fact that the last approximation is still an unknown distance short of the goal.

Reactor Analysis in my opinion fails to give an accurate picture of both the scope and the accuracy of what can be done today in analyzing reactor problems.

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Reactor Analysis. By Robert V. Meghreblian and David K. Holmes. McGraw-Hill, New York, 1960. 808 pp., $19.50. [*Review No. 2.*]

What is "reactor analysis"? The authors of the book *Reactor Analysis* define it as dealing "with the mathematical tools for treating the physical behavior of reactors," and this definition seems reasonable enough to me. Whether or not the coverage of reactor analysis is adequate in the book under review is another question, however, and largely because of the authors' sins of omission, I must answer in the negative. On the other hand, the authors have produced a book which covers reasonably well some of the basic concepts of reactor physics in a careful and mathematically rigorous manner. Because more such care and rigor are found in this book than in the other reactor texts with which I am familiar, I feel that *Reactor Analysis* can be recommended as an advanced text in reactor physics (although it is certainly far from ideal).

Some of the sins of omission referred to earlier will be enumerated presently, but first it should be pointed out that one man's "sins of omission" may be another man's trivia. However, in the present case, I do *not* feel that many of the textual lacunae to which I object can properly be classed as unimportant in the field of reactor design. I base this statement on my experience in the reactor core design area, both in the Naval Reactors Program at KAPL and later as a consultant to the AEC and a number of private industries.

Holmes and Meghreblian, on the other hand, have had (so I understand) a fairly "academic" association with reactor physics at Oak Ridge, teaching at ORSORT and, in their own research programs, not being too strongly involved in actual design. For this reason, they may not be, and apparently are not, sufficiently familiar with the design methods commonly in use in the industry to produce an authoritative text on analysis. Some of the more serious omissions are: the Hurwitz-Roe absorption area technique for control rod calculations; the Greuling-Goertzel approximation to slowing-down; the work of Wigner and Wilkins on the calculation of thermal spectrum, and the extensions of this work carried out by Nelkin, Cohen, Amster, and others;[1] Dancoff's corrections to resonance absorption (mentioned only through a reference); the recent work of Bell which provides a useful tool for approximate Dancoff calculations; the use of Fourier-transform slowing down calculations for obtaining group-diffusion constants. The list could go on and on, but perhaps the above will provide enough illustrative examples.

[1] The only thermal spectrum calculations discussed are those of Coveyou, Bate, and Osborn carried out at Oak Ridge.

However, *Reactor Analysis*, considered as a reactor physics text, is acceptable—largely because of its lack of competition. The other leading contenders for use as such a text have serious deficiencies—Glasstone and Edlund is out of date and also too sloppy—Weinberg and Wigner is too erudite, and thus is a far better reference book than a textbook; Murray is somewhat too elementary, although it does have the advantage of including many modern analytical methods, as well as some excellent illustrative problems. It is interesting to note that all of these books, as well as *Reactor Analysis*, are products of Oak Ridge, which fact is probably propagating an "Oak Ridge Bias" in the minds of nuclear engineering graduate students the world over.[2]

As a textbook of reactor physics, most of the deficiences of Meghreblian and Holmes' treatise are due to clumsy and over-formalistic methods. For example, I have never been able to understand why the elegant Hurwitz-Brooks approach to perturbation theory, via iterated fission probability, is not generally used in textbooks. Perhaps this is due to the "Oak Ridge Bias" mentioned above. This is a real pity, as not only are the resulting formulas much easier to work with, but the whole approach is much more comprehensible, particularly to students. Also, the discussion of resonance escape probability could be handled in a much clearer fashion than the one which the authors have chosen—this choice is particularly unfortunate, as it makes a physical understanding of some of the important approximations (for example, the neglect of multiple scattering in the NRIA approximation) rather difficult to come by. The chapter on transport theory suffers from the same illness that one finds in Davison and Weinberg and Wigner—"subscriptitis." I am sure that it must be possible to discuss this topic without confusing the reader as thoroughly as all of the writers in the field have succeeded in doing. (In passing, one notes the rather startling omission of any discussion of double P_n calculations or numerical quadrature schemes such as S_n in the chapter on transport theory). The chapter on nuclear physics is so weak that it should have been omitted entirely. And the section on group-diffusion theory follows the same tortuous treatment initially (and unkindly) foisted on a gullible public by Glasstone and Edlund. (I say gullible because apparently a generation of reactor physicists and engineers has blindly accepted this treatment without realizing that a good treatment exists.)

A final gripe is the absence of such fundamental experimental techniques as inverse multiplication, rod drop, and pile oscillator measurements. (Of course, if the title of the books were changed to "Reactor Theory," I suppose this would not be a legitimate complaint, but as the book stands the coverage of experimental techniques is very poor.)

The best features of the book are first, as was mentioned previously, the care and at least partially rigorous approach so lacking in many other texts (notably Glasstone and Edlund) and the measure of clarity also notably absent elsewhere (notably Weinberg and Wigner.) Of particular excellence is Chapter 12 on hydrogenous systems and

[2] As an example of this bias, we find no reference to fast reactor calculations in the book. Furthermore, the design methods which originated or have been popular at Oak Ridge are strongly stressed—the methods associated with other laboratories tend to be ignored.

Chapter 5 on diffusion theory. In addition, the authors must be commended for the inclusion of a number of interesting applications (for example, the kinetics of a circulating fuel reactor), and despite the many omissions of analytical techniques, the inclusion of others not generally found in textbooks, as, for example, the Russian approach to heterogeneous reactor calculations.

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Applied Gamma-Ray Spectrometry. Edited by C. E. CROUTHAMEL. Pergamon, New York, 1960. 443 pp., $6.50.

This book is the second volume of an International Series of Monographs on Analytical Chemistry. While it is addressed chiefly to the analytical chemists, it will be of interest to anyone involved in the measurement of gamma-ray spectra from radioactive isotopes. Actually, the book is devoted almost entirely to the theory and application of scintillation counters to gamma-ray spectroscopy; a brief section on proportional counters is included but better discussions of this topic can be found in other works.

The book is divided into two parts. The first 155 pages are largely descriptive and consist of four chapters. The first chapter, "Intrinsic Variables," is one of the best condensed discussions of decay schemes and the interaction of radiation with matter that has come to this reviewer's attention. The second chapter, labeled "Extrinsic Variables," deals chiefly with the processes that take place in converting a gamma photon into a voltage pulse. It is apparent that Messrs. Managan and Crouthamel, the authors, have given a great deal of thought to all the factors that enter into obtaining good resolution in a spectrometer. It is unfortunate that the recent work by R. B. Murray was not available, for it would have done much toward clearing up the mystery of the lower limit on resolution. Actually, the authors must be somewhat psychic for they state "A possible explanation lies in the conversion variance (gamma-ray energy into photons) resulting from nonlinearity in NaI(Tl) scintillator." A smattering of electronic circuitry also appears in Chapter 2, which leads this reviewer to conclude that electronics is not the forte of the authors. Chapter 3, though brief, is devoted to the calibration of the detectors. Chapter 4 on "Specific Applications" is addressed chiefly to the analytical chemists and will, I am sure, be required reading by any student entering the field. I was startled by Table 4-5 which lists the isotopic concentration of U^{235} occurring in "natural" uranium as 0.39%. Of course, the original analysis was done with depleted uranium.

The major part of the book, and undoubtedly the part that will appeal most strongly to analytical chemists, is that comprising the four appendixes. A list of the titles and page lengths of each follows:

I. X-ray Critical Absorption and Emission Energies in kev—4 pages
II. A Compilation of Gamma-ray Spectra—150 pages
III. Intrinsic Efficiencies of Right Cylindrical Sodium-Iodide Crystals—27 pages
IV. Photon Energy, Atomic Number, and Half-Life Sequences of the Nuclides—95 pages

Appendix II consists of hundreds of scintillation spectra which were obtained at Argonne National Laboratory with a 4 × 4 in. NaI(Tl) crystal spectrometer. The first spectrum is that of Be^7, the last that of Am^{241}. While these spectra will be most valuable to anyone trying to identify an unknown isotope, the analyst must recognize that unless his spectrometer also uses a 4 × 4 in. crystal of similar resolving power, the spectrum that he observes will be different from that shown in Appendix II. Also, many spectroscopists prefer the use of semilogarithmic plots and will therefore refer to Heath's "Gamma-Ray Spectrum Catalogue" for their own use.

Anyone who has ever observed a gamma ray and wondered what it might be coming from will recognize the value of Appendix IV, which catalogues all of the known gamma rays in a table of increasing gamma ray energies. (It has been pointed out to me that there is a misplaced decimal point in the value of the Ce^{145} gamma-ray energy.)

The index at the end of the book is too brief (one page) but this is more than compensated for by the complete set of references. The editor and publisher are to be commended for listing the references throughout the text rather than putting them at the end of the chapter.

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Fast Neutron Physics. Part I: Techniques. Edited by J. B. MARION AND J. L. FOWLER. Interscience, New York, 1960. 983 pp., $29.00.

This volume together with the forthcoming Part II (Experiments and Theory) covers the broad field of fast neutron physics. These two volumes give comprehensive treatments of topics in this rapidly expanding field of research. They should serve as a most valuable reference both to the research scientists in this field as well as to reactor engineers, health physicists, and all others who work with neutrons. The topics which are covered in Part I are (I) Neutron Sources, (II) Recoil Detection Methods, (III) Detection by Neutron-Induced Methods, and (IV) Special Techniques and Problems. Each of these sections has a number of subsections written by specialists in the field.

Section I contains comprehensive information about radioactive neutron sources and detailed information on monoenergetic neutrons from charged particle reactions. Section II gives an excellent coverage of recoil counters, recoil detection by scintillators, and recoil telescopes as well as the older methods of detection: photographic plates and the cloud chamber. Section III includes treatises on flat response counters (long counters), helium-3 neutron spectrometers, gaseous scintillation detectors, and fission detectors. The last section includes topics of a rather diverse nature but of considerable interest and importance: time-of-flight techniques, neutron flux measurements, neutron collimination and shielding, fast neutron dosimetry, fast neutron radiation hazards, and computer techniques.

This reference book should prove indispensable to those working with fast neutrons particularly since this collection of the latest technical information includes much data that that have not been published previously.

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