Book Reviews

Annual Review of Nuclear Science, Volume 18. Emilio Segré, Editor, Annual Reviews, Inc., Palo Alto, California (1968). 528 pp., $8.50.

This is the 18th volume of the well-known review series. As usual, it covers a very wide variety of subjects from biological effects of radiation, instrumentation, technology, to nuclear and elementary particle physics. Some of the contributions are oriented towards the experimental and others toward the theoretical side. Thus, no single reader will be equally interested in all articles nor a single reviewer be able to judge all of them with competence. One feature is of outstanding value in this series. Each author provides an extensive list of references up to a stated cut-off date (in this case, February to July 1968), and gives in the text generally adequate hints as to their contents. The short time lapse between these dates and the actual appearance of the book (January 1969) is equally commendable.

Since the desired audience is large, most articles are not quite monographs in depth, and rightly so. They should, however, convey the spirit of the subject without going into tedious details. This reviewer's principal criterion for his judgment has been how much he enjoyed reading a particular contribution. A list of contents follow with short remarks added.

Shell-Model Theory of the Nucleus, by H. J. Mang and H. A. Weidenmüller, gives a rather brief and formal review without much of the physical reasoning behind the newer developments.

High-Isospin Nuclei and Multiplets in the Light Elements, by Joseph Cerny, collects the rich experimental information now available on high-isospin nuclei at the limits of nucleon emission stability and of the nuclear reactions that lead to these states.

Elements Beyond 100, Present Status and Future Prospects, by Glenn T. Seaborg. It is astonishing that the busy chairman of our USAEC could find the time to write a 100-page essay even if it is on a subject close to his heart. As such, it is authoritative, comprehensive, and well-organized. As to the conclusions, read the article yourself.

Review of Nuclear Weapons Effects, by Harold L. Brode. This is a difficult subject to cover since the phenomena are highly complex and the literature is largely classified. The author, however, succeeds fairly well to give a coherent picture of the time sequences and the scaling laws as far as they can be developed without going into the details of the devices. Only surface and air bursts are covered but not underground ones as would be needed for Plowshare applications.

Nuclear Propulsion for Space Vehicles, by R. S. Cooper, is a very short introduction to a highly sophisticated technological problem. After a brief review of performance requirements for various missions, the various features of a "conventional" nuclear rocket (solid core, hydrogen as propellant) are described and then some advanced concepts (liquid and gas core reactors, nuclear explosions as propellants) are discussed.

Current Algebra, by J. D. Bjorken and M. Nauenberg, deals with one of the most recent and sophisticated methods invented by present-day particle physicists. Yet the authors succeed very well in elucidating the physical reasoning behind the various procedures and the results obtained. The requirements on the reader are somewhat more demanding than for the other parts of this volume, i.e., quantum mechanics, the Dirac equation, low energy β-decay, and some knowledge of the phenomenology of high energy physics. Those who have these tools will find their understanding greatly improved.

The Measurements of Short Nuclear Lifetimes, by A. Z. Schwarzschild and E. K. Warburton, reviews the various experimental methods to measure lifetimes of excited nuclear states (with a time range down to 10^{-15} sec). Discussed in some detail are the delayed coincidence, the recoil-distance, and the Doppler-shift attenuation methods.

Magnetic Dipole Moments of Excited Nuclear States, by L. Grodzins, discusses the experimental methods, gives tables of some of the results, and compares them with theories as far as they have been developed. This is an exciting field which has given much information about the nature of the collective states in nuclei and promises to give still more in the future.

Compound Nuclear Reactions Induced by Heavy Ions, by T. Darrah Thomas, reviews in considerable detail the statistical theories for these complex reactions. Angular momentum considerations play here a predominant role. Also the separability of the cross sections into compound nucleus formation and later de-excitations is discussed fairly thoroughly. The impression left is that one has so far only a partial understanding of these involved phenomena and that much remains to be done.

The Radioactivity of the Atmosphere and Hydrosphere, by D. Lal and Hans E. Suess, discusses mostly the sources of radioactivity, that is, primary, cosmogenic, and artificial radionuclides. Their many uses for the study of geophysical phenomena are only hinted at.

Accelerators for High Intensities and High Energies, by Ernest D. Courant gives an up-to-date review of the present state of the art. After a discussion of the various intensity limitations, it describes some of the projected high-intensity accelerators, synchrotrons above 10^{11} eV, and storage rings and colliding beams. The recent idea of using relativistic electron beams to carry along ions is not yet included.

Materials for Water-Cooled Reactors, by W. C. Francis, discusses the various prerequisites imposed by the nuclear and power environment on the various components of water-cooled reactors, that is, fuels, coolants, moderators and reflectors, control rods, and structural materials.

Effects of Radiation on Man, by Arthur C. Upton, provides a readable overview of this complex subject. After a description of radiation sickness and its syndroms, it describes the effects of prenatal irradiation, on longevity, on the incidence of cancer, and later somatic and genetic incidences.

As can be seen from this summary, the book provides quite a diversified menu. At its price, it is a bargain!

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About the Reviewer: Lothar Nordheim is a consultant for Gulf General Atomic Incorporated where he previously served as Chairman of the Theoretical Physics Department and as a Senior Research Advisor. Educated in Europe, he taught at Purdue and Duke Universities and also held positions at the Oak Ridge National Laboratory and at Los Alamos. His work in theoretical physics covers a wide spectrum including reactor, neutron, and nuclear physics. He is a Fellow of the American Nuclear and Physical Societies and a member of the Editorial Board of Nuclear Science and Engineering.

Engineering Compendium on Radiation Shielding, Vol. 1: Shielding Fundamentals, and Methods. Editor-in-Chief, R. G. Jaeger. Springer-Verlag, New York, Inc., New York and Berlin (1968). $60.00.

It is probably feasible to write a reasonable sounding review of this long-awaited volume without ever opening the covers of the book, or at least without going past the table of contents. One could hail the brilliant constellation of authors, a veritable who's-who of shielding experts, and pay tribute to the band of devoted editors who brought the volume to a successful completion. The breadth and detail of coverage could be praised, noting especially how much information is here gathered together that had previously been available only in widely scattered report literature. The long gestation period of the volume could be regretted, as it undoubtedly resulted in some of the material being obsolete before publication. It would also be safe to express some mild unhappiness over occasional duplication and diversity of viewpoints arising from the large number and variety of authors represented. And above all, one could deplore the exorbitant price of the volume, which restricts the access of those who indeed need-to-know more than any security classification could.

It would all be indisputably true—especially the last point. However, this volume, which has been the object of such concentrated effort by authors and editors, and which is of such potential value to the shielding community, calls for a discussion both more detailed and less superficial. In genesis, the *Engineering Compendium* of *Radiation Shielding* had the aim of providing a handbook of engineering solutions to design problems. The emphasis was intended to be on the words *engineering* and *design.* Sponsorship and overall guidance has been supplied by three of the divisions of the International Atomic Energy Agency. Early in the discussions of the editorial board convened by the Agency it was decided to broaden the task "to include well-referenced basic data for the research worker," to quote the preface. The aim, it was decided, would be (quoting further) "a complete presentation of the subject, covering and linking both the technology and the science of shielding." What has been published so far is Vol. 1 *Fundamentals* and *Methods* and for the most part corresponds to the science of shielding. The technology is still to come in Vol. 2, which will consist of a chapter on shielding materials and a long section on a wide range of shielding design situations ranging from shipping casks to ship propulsion reactors.

The magnitude of the material gathered here in Vol. 1, and the manpower required for the assembling, leave one a little shaken. The text comprises about 530 double-column printed pages. By my count, some 67 authors contributed and a distinguished board of seven editors (including the late E. P. Blizard) were needed to ride herd on them and coordinate their efforts as far as possible. The number of distinct and separately authored articles is difficult to determine, but must well exceed 50, ranging from less than a page or two (cf., that on photoneutron sources) to 25 page articles (such as that on neutron penetration in hydrogenous media). This collection of separate papers is grouped in 8 chapters organized along what are by now reasonably standard lines. After an introductory chapter on radiation units and limits there is a lengthy discussion of radiation sources. A general chapter on attenuation methods is followed by individual chapters on gamma-ray and neutron attentuation. Point kernel methods get a whole chapter followed by the last two chapters on heating in shields and the treatment of ducts and voids.

One naturally thinks of the previous handbooks in the shielding field, starting with the "Reactor Shielding Design Manual" (TID-7004), then the shielding portion of the first edition of the U.S. Atomic Energy Commission's *Reactor Handbook* (declassified version in AECD-3645) and most recently, the shielding volume of the second edition of the *Reactor Handbook* (Wiley-Interscience, 1962). What has the present volume of the Compendium to offer beyond these? One obvious and very important advantage is a greater timeliness. The last previous handbook is dated 1962 but was in fact completed in 1959 or 1960. Another is an international viewpoint. Previous handbooks had been confined to the US effort (and sometimes only a small part of *that*). While the majority of the Compendium authors come from the US (43) some nine other countries are represented, the USSR, alone, supplying ten authors. Finally, the material is not restricted as in the past to reactor shielding but the needs of other radiation sources, such as accelerators, are considered.

The Shielding Compendium thus seems to have every factor in its favor. And yet, turning its pages and making use of articles both in teaching and research, a definite sense of dissatisfaction, or better: unsatisfaction, develops. A number of the reasons for this feeling of disappointment are easy to identify. For example, on closer examination some of the advantages over the older handbooks have a tendency to evaporate, or at least show some drawbacks too. Thus, although the volume did not become available here till early this year, many of the articles had been written as long as three and four years ago. Even if I did not know this of personal knowledge, it would be clear from the reference lists, which rarely show anything beyond 1965. In a field where change can at times be rapid, the risk of "stale" information can be high. Some of the articles were, however, obviously written close to press time, resulting occasionally in a curious distortion of perspective. For example, both the NIOBE and the S_N solutions of the transport equation get articles about 10 to 11 columns long each. There is nothing (except perhaps the dates of the respective references) to inform the reader