Book Reviews

Experimental Neutron Resonance Spectroscopy. By J. A. Harvey, Ed. Academic Press, New York (1970). 534 pp. $31.00.

As one who has done research in the field of neutron resonance spectroscopy since 1941, I am quite familiar with the material this book covers. For a reader seeking an introduction to the subject, I would consider the book to be generally excellent. It is divided into five sections (chapters), each having one or two authors, with the varying styles of the different authors, and some, but not excessive overlap. The material mainly describes the situation as of 1968, with some of the developments of 1969 and 1970 included near the ends of the chapters, a reflection of publication deadlines. The emphasis is on time-of-flight resonance spectroscopy below ~10 keV.

Chapter I, "Pulsed Accelerator Time of Flight Spectrometers," is by the late Earnest Rae (Harwell) and W. M. Good (ORNL). A thorough description is given of the various sources which have been used—cyclotrons, electron linear accelerators, nuclear explosions, Van de Graaff, and pulsed subcritical fission assemblies. Table I gives the performance figures for various circular accelerators, and Table III gives those for the numerous electron linacs, which provide the main sources for this work today. There is a good discussion of target moderator assemblies, flight paths, and detector stations. Multichannel data systems presently tend to emphasize modern, fast on-line computers with appropriate interfaces. This is a rapidly changing field. About nine pages are devoted to the Nevis synchrocyclotron for pulsed neutron time-of-flight spectroscopy as of ~1968 (my research facility). The main emphasis is properly on electron linac systems, including the excellent new Oak Ridge Electron Linear Accelerator (ORELA) which had barely started operation by 1970. There is much otherwise hard-to-obtain material in this chapter from laboratory reports and specialized conference proceedings. About 25 pages are devoted to the pulsed Van de Graaff (W. M. Good) which has some unique advantages over a limited energy interval, but which will probably be replaced mainly by systems such as ORELA in the future. This chapter also contains many examples of experimental results which help to illustrate and supplement the material in the subsequent chapters.

Chapter II, "Total Neutron Cross Sections," by F. W. K. Firk (previously at Harwell) and E. Melkonian (Columbia), in about 50 pages discusses nearly all of the important aspects of data analysis at a level that gives an uninitiated reader an understanding of the subject. The chapter should give more attention to the importance of a reliable monitor system in measurements, and on the problems of the energy dependent and transmission sample influenced background corrections. These are most important and frustrating problems for the experimenter to treat correctly, which he must do to obtain correct results. The discussion in Sec. III.B on "Area Analysis" describes approximation methods and gives diagrams that are mainly of historic interest. With the present use of large computers, both as on-line time-of-flight multichannel fast storage systems and subsequent data processing, the principal active laboratories have (mainly) evolved their own elaborate computer programs (mainly unpublished) which make fast accurate evaluation of the required analysis relations always including Doppler and potential resonance scattering interference corrections. The most important results using the Columbia Nevis Synchrocyclotron, for example, have mainly been published starting in 1972. Readers interested in results of this system are referred to *Phys. Rev. C* [**5**, 974—erbium; **5**, 1002—tests for *p* versus *s* levels; **6**, 251—samarium and europium isotopes; **6**, 435—analysis; **6**, 5—^{232}Th and ^{238}U; **7**, 823—ytterbium isotopes; **8**, 1813—tungsten isotopes (an appendix here describes modern techniques for evaluating the Doppler integrals)]. Some of the computer programs use very large computer-generated analysis tables (computer stored) which would require more than 50 pages for listings and are not published.

In the discussion of the statistical properties of resonances, pp. 145-151, the pre-1970 aspect is evident from the lack of discussion of the Dyson-Mehta theory of long-range ordering of level spacings (single population) and our confirmation for even-even rare earth nuclei and tungsten. A discussion of intermediate structure, such as for subthreshold fission (see pp. 48-49, Chap. I) is conspicuously missing here.

Chapter III, "Neutron Scattering and Capture Cross Section Measurements," is by Earnest Rae and Robert C. Block. This is a field where these authors have made important contributions (Harwell and RPI). The presentation is excellent. These measurements are, in many ways, more difficult than transmission measurements because of complications due to scatterings into resonance followed by resonance capture or scattering. The reader of this book should also read J. E. Lynn's book, *The Theory of Neutron Resonance Reactions* (Oxford, 1968). On p. 23 of his book, Lynn shows how scattering results for the broad, mainly scattering resonance at 130 eV in cobalt can give extreme multiple scattering distortion to the data. That figure and its discussion supplement Chap. III of this book. Emphasis was given here to the Harwell studies for ^{232}Th where total σ, σ_{scatt}, and σ_{capt} versus E were separately measured. These results have subsequently been criticized by Ribon (Saclay) for the inconsistency of the parameters from the total σ and the σ_{scatt} measurements. The Saclay group obtains Γ_γ and Γ_n values from shape fits to resonance transmission data. The latest Columbia ^{232}Th and ^{238}U analysis (*Phys. Rev. C*, **6**, 5) used transmission measurements, self-indication measurements, and

Moxon-Ray detector capture results. The scattering measurements seem to be useful mainly in very special cases. Great care is needed to avoid errors due to multiple scattering, etc., to avoid misleading and wrong results.

Chapter IV, by Lowell Bollinger [Argonne National Laboratory (ANL)], "Gamma Rays from Neutron Capture in Resonances," is excellent, although giving perhaps overly extensive accounts of the settling of controversies of mainly historic interest where Bollinger's results finally proved to be definitive. At the end of the chapter (Fig. 35) I finally found the very interesting recent ANL results (partly presented here) on their gamma-ray measurements where neutron capture is over many resonances (also Figs. 8 and 9). Since 1968, experimental work has emphasized the use of high resolution Ge-γ detectors. Capture involving many resonances to remove fluctuations in Γ_γ, to particular final states, have yielded results important to the theory of the EI, EII, MI, MII, etc. transitions versus gamma-ray energy, and in establishing the compound nucleus bound levels. Bollinger has pioneered in developing many of the techniques discussed in this chapter. Other examples are in Chap. I.

The final chapter, "Measurements on Fissile Nuclides," by M. S. Moore, covers many of the types of experiments and results in neutron fission physics. It is the only chapter completely lacking figures on experimental systems. A reader of this and the other chapters would profitably supplement the subject matter by browsing through various editions of BNL-325. The σ_t, σ_f, etc., versus E curves in Chap. V, and the extensive tables of resonance parameters should be supplemented by the more recent resonance parameters in the (1973) third edition (Vol. I) of BNL-325, and the cross curves in BNL-325, second edition, Supplement 2 (Vol. III for fissile nuclei). The recent Lawrence Livermore Laboratory publication (UCRL-50400, Vol. 7, Part II) presents the most recent curves. One obvious minor mistake I caught was the factor of 10 error in labeling the ordinate in Fig. 21 (a) of σ_f for ^{239}Pu, since σ_f is shown as $>\sigma_t$ (p. 410) for 68 eV $< E <$ 98 eV.

After reading Chap. V, I reread the review article (1966) "Neutron Fission" by J. F. Fraser and J. C. D. Milton (*Annual Review of Nuclear Science*, Vol. 16) to supplement Chap. V. Their initial comment is appropriate: "We know a great deal about Nuclear Fission, but understand rather little." This comment is useful in reading Chap. V.

I recommend this book to the reader interested in learning about this subject.

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About the Reviewer: James Rainwater is professor of physics at Columbia University where, since 1941, he has been engaged in research on neutron resonance spectroscopy first with the Pupin cyclotron and, over the past 15 years, with the Nevis synchrocyclotron. He spent the World War II years on the Manhattan Project and in 1950 authored the well-known paper on the spheroidal nuclear model. Dr. Rainwater did his undergraduate studies at Cal Tech and completed his graduate work at Columbia. He is a fellow of APS, IEEE, AAAS, and the New York Academy of Sciences, received the USAEC's Lawrence Award in 1963, and is a member of the National Academy of Sciences.

Nuclear Energy: Its Physics and Its Social Challenge. By David Rittenhouse Inglis. Addison-Wesley Publishing Co., Reading, Mass. (1973). 395 pp. $4.95 (paperback).

An unexpected thing happened on my way to the end of this book. I noticed on p. 150 a grudging statement about "a gratifying beneficial use of nuclear radiation."

I thought this was interesting and worth telling because it all started at the Preface where it said that the book was designed for a college course for a general "arts" student who wants to understand the physics and sociopolitical aspects of nuclear energy." I even fancied myself as ". . . the reader who is youthful at least in spirit, . . ." and I hoped to have "a piercing glimpse into both the scientific and humanistic aspects of nuclear energy problems, including the problems of nuclear weapons, from the point of view of a scientist who professes enough concern that he may be given heed."

At this point I sort of expected to read something about nuclear (electric) power and why it was important. There was indeed a lonely terse statement in the Introduction that "nuclear energy, when and if it becomes an important contributor, will be important mainly as a producer of electric power." And then after the first three chapters which delt with the physics underlying the operation of atom bombs and nuclear reactors, I thought that finally there would be some good reasons why nuclear power seems to interest many people besides nuclear engineers and physicists.

But in the fourth chapter on "Nuclear Reactors as a Power Source" I kept reading about troubles and "Thus nuclear generation has almost but not quite caught up with coal fired generation of electricity in economic cost, if we overlook certain subsidies of the nuclear enterprise." The discussions of the reactor accidents at Chalk River, Windscale, Fermi, and SL-1 were pretty sobering, and the China Syndrome and WASH 740 didn't help.

*Chapter 5 on the "Effects and Uses of Radioactive Prod*ucts" told how radiation produces mutations, and "Thus each mutation is in a sense a curse on society that will eventually make trouble in some future generation." There was nothing about dose rate effects, fractionation of dose, or genetic and somatic repair. I found there that "Rem stands for 'Roentgen equivalent mammal,'" which I guessed as OK since a man is a mammal. There was the celebrated 30 000 deaths/yr argument of Gofman and Tamplin, but nothing about the ideas of their critics, or other opinions like the BEIR Report (Nov. 1972), which concludes that the Gofman-Tamplin risk estimates are about 10 times too high. There was a cogent observation about a conclusion made by Sternglass, "There is a tendency for it to be believed or not according to the prejudices of the critic." And after a few sentences more ". . . If infant mortality and malformation as a result of permitted exposures from nuclear power plants might be 10 or 100 times those surmised by Gofman and Tamplin, as Sternglass further concludes, this casts further doubt on the advisability of such a program." I reread the bit about the prejudices of the critic, and wondered if I just had a "piercing glimpse."

Finally, in sections about medical and industrial uses of radiation, there it was on p. 150, "a gratifying beneficial use of nuclear radiation."

The next chapter dealt with the substantial problems of nuclear bomb proliferation, and the diversion of fissile materials to make bombs. About here I started wishing my prejudices hadn't been jangled because it seemed what I was reading made some sense.

The chapter on "Other Possible Power Sources and Fu-