International Journal of Applied Radiation and Isotopes, Vol. 32, pp. 687 to 688
Pergamon Press Ltd 1981. Printed in Great Britain

BOOK REVIEW

Nuclear Chemistry: Theory and Applications by GREGORY R. CHOPPIN and JAN RYDBERG. Published by Pergamon Press, Headington Hill Hall, Oxford OX3 0BW, England. 667 pp. Price U.S. $87.00 (hardcover); $29.50 (softcover). ISBN 0 08 023823 8.

NUCLEAR chemistry has always been a rather peculiar discipline which nearly defies definition. For the most part, it is the subject pursued by chemists who do nuclear physics. As a result, practitioners tend to place greater reliance on chemical techniques and to apply nuclear physics to chemical problems. Students of nuclear chemistry have had to rely on texts that were either very chemistry or application oriented, and short on physics; or very nuclear physics oriented, and short on chemistry. An example of the former is the excellent text by M. Haïssinsky (*Nuclear Chemistry and Its Applications*). In contradistinction, the text used for my first course in "nuclear chemistry" (*sic*) was the classic *The Atomic Nucleus* by Evans (which was also simultaneously used by the physics department for a first course in nuclear physics). Few texts have ever adequately provided coverage of both aspects. The few that do provide a reasonable balance are now considerably dated and do not cover many of the more recent experimental and applied advances.

Choppin and Rydberg have admirably filled this gap. They have written an up-to-date text for chemists that they believe can be used for either an upper-level undergraduate or graduate-level first course in nuclear chemistry. There is little doubt that the book was written for chemists since terms like "molar concentration", "valence", "pH", "anions", "redox", "electrolytes", "solubility product" and "ppm" are used without explanation. Rather than treating select topics in depth, the authors provide a very broad, nearly encyclopedic, coverage of the whole field. There is an excellent balance between coverage of the basic science, experimental techniques, and practical applications. Their treatment of the nuclear-fuel cycle is particularly complete. Few topics seem to be missed. In fact, I was hard pressed to find any topic from the fields of nuclear physics, radiochemistry, isotope chemistry and radiation physics which are not at least cursorily mentioned.

Most readers will, of course, find select topics which they would have preferred to see treated in greater depth. The first chapter contains an interesting historical survey of nuclear science, but is much too brief. Surprizingly, the authors did not include in their general reading list the excellent *Early History of Radiochemistry* by H. W. Kirby (Mound Laboratory, Miamisburg, Ohio, Report MLM-1960, 1972, 126 pages). Considering the growing concern and increased attention to the potential health hazards of radiation exposure from natural environmental radioactivity, the role of radon in indoor environments may have deserved more than a brief, passing mention. Similarly, Chapter 16 (Radiation Biology and Radiation Hazards) only lightly touches upon the questions and controversy surrounding the validity of extrapolating from the effects of high radiation doses to the effects of low population doses.

Chapter 17 (Detection and Measurement of Nuclear Radiation) does not cover any of the direct-measurement methods, such as beta–gamma, sum-peak, or photon–photon coincidence counting, which are not based on calibrations with radioactivity standards. These are personal choices, however, and it is difficult to fault any introductory book for omissions when it contains nearly 600 pages of textual material.

At the same time, most readers will be impressed by the excellent coverage given to some topics. Two of my favorite chapters are 10 (Production of Radionuclides) and 18 (Applications of Radioactive Tracers). The first contains a good treament of the combined production and radioactive decay of second-order reaction products (a topic not frequently found in introductory texts), as well as descriptions of the fascinating on-line detection systems and rapid chemical-separation techniques. The second contains a survey of the important applications of radioactive tracers in various fields of science, industrial processes, and diagnostic nuclear medicine. This chapter is somewhat unique since the authors seldom separated theory chapters from application chapters. In most cases, they have achieved a very natural blending of basic principles and applications within the chapter itself. Even in Chapter 6 on nuclear structure where one might expect to find nothing but theory, there is a nice section on the experimental details and application of nuclear magnetic resonance. This hand-in-hand presentation of theory and application is one of the nicest features of the book. In addition to 21 very full chapters, the book contains a number of appendices. Appendix B and C on isotope effects in chemical equilibrium and chemical kinetics are particularly interesting. Beside separate author and subject indices, there is an element and nuclide index which is very useful.

The book's most serious failing is the inclusion of Chapter 21, entitled "Nuclear Power: Problems and Promise." In this final chapter, the authors address the opposition to nuclear power by discussing "the basis of that opposition" and attempting to "evaluate the validity of these concerns." Although the authors forthrightly caution readers that their "evaluation and final conclusions are somewhat subjective", the treatment is decidedly pro-nuclear. Much of the content of this chapter involves societal issues and choices, and not a purported scientific validity or invalidity. Many of the arguments are at best debatable, and at times are outrightly dubious or fatuous. The latter is exemplified by their comparison of the Three Mile Island accident with an expected accident frequency from the Rasmussen Report analysis:

"It is interesting that the Rasmussen analysis predicted an accident of the Three Mile Island type to have a probability of once in 8000 reactor years, whereas it actually happened after 3000 reactor years. Such an agreement would seem to add support to this analysis."

Whether one agrees or disagrees with the author's conclusions, this type of advocacy is inappropriate in a textbook. I do not know of any text on organic chemistry, for example, which has found it necessary to discuss the advantages and disadvantages of developing new chemical products, or the problem of hazardous waste disposal. Similarly, I do not believe that it is either necessary or desirable to include an analogous treatment in a nuclear chemistry text.

The last criticism is not meant to seriously detract from my admiration for this otherwise excellent work. I suspect

that because of its merits it will probably become the most widely used text for a first course in nuclear chemistry. Compared to existing texts, it should be welcomed by all future students. At the same time, it should be a useful addition to the reference bookshelf of practicising nuclear chemists who wish to obtain a cursory treatment of some of the more recently applied advances in the field, or a quick refresher on a topic they have long forgotten.

The views expressed here are those of the reviewer and not necessarily those of the National Bureau of Standards.

R. Collé
National Bureau of Standards
Washington, D.C.
U.S.A.