the ring protons and the concomitant gradual increased shielding of the β-protons may conceivably indicate a progressively increasing radial expansion in the size of the d-orbital(s) responsible for the shielding, proceeding from the iron to the ruthenium to the osmium derivatives.[8] The effects observed and the interpretation advanced can be compared with the information obtained from the comparative chemistry of these metallocenes.[9] Since the proton shifts indicate selective shielding or deshielding in certain regions of the molecule, any comparison of the chemistry of these compounds must also be made between equivalent regions only. If done accordingly, the deductions drawn from chemical shifts appear to parallel many of the conclusions concerning relative electron densities derived from the chemistry of this metallocene triad.

We are pursuing the implications of these findings in order to understand better the "topography" of metal d-orbitals and specific metal effects in metallocene chemistry. The results of such a study might also prove useful in clarification of the bonding in metallocenes, since this topic is presently the subject of some controversy.[10]

(8) There is conceivably a parallelism between the plots of Fig. 1 and similar plots using either the covalent radii (1.165, 1.241, and 1.255 Å.) or the atomic volumes (7.10, 8.18, or 8.38 cc.) of iron, ruthenium, and osmium, respectively. The values are from T. Moeller, "Inorganic Chemistry," John Wiley and Sons, New York, N. Y., 1952, pp. 870–872.

(9) For a review, see M. D. Rausch, *Can. J. Chem.*, **41**, 1298 (1963).

(10) G. Wilkinson and F. A. Cotton, *Progr. Inorg. Chem.*, **1**, 1 (1959); J. P. Dahl and C. J. Ballhausen, *Kgl. Danske Videnskab. Selkab Mat.-fys. Medd.*, **33**, 5, 111 (1961); E. M. Shustorovich and M. E. Dyatkina, *Zh. Strukt. Khim.*, **3**, 345 (1962).

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RECEIVED JANUARY 13, 1964

Book Reviews

Teaching Chemistry with Models. By R. T. SANDERSON. D. Van Nostrand and Co., Princeton, N. J. 1962. 175 pp. 15 × 23 cm. Price, $5.75.

Models of organic and inorganic molecules and of various crystal types have been available commercially for many years now. However, due mainly to their size, the small models are not satisfactory for lecture demonstrations. Consequently, there have been numerous articles discussing "do it yourself" methods of constructing larger models using styrofoam or other suitable materials. Articles by J. A. Campbell: "Structural Molecular Models," *J. Chem. Educ.*, **25**, 200 (1948), and "Some Simple Solid State Models," *ibid.*, **34**, 210 (1957), have been particularly useful among some 40 papers on this subject.

In this book R. T. Sanderson, of the State University of Iowa, summarizes some methods of making and using models. He has developed his own scale of electronegativities and shows this for each element by using a color-coded scale from blue to green to yellow to orange to red for the atoms from fluorine to cesium. The atomic models also show the relative size of atoms (using covalent radii only), the distribution of electrons, and the valence orbitals.

The molecular models show the geometric structure, the multiplicity of bonding, and the charge distribution. Sanderson uses tangent spheres with the appropriate covalent radii, rather than using both van der Waals and covalent radii as used in most models such as the Fisher–Hirschfelder type which are preferred by most chemists. His rationalization of his personal preference, on p. 21 of the book, was not particularly convincing to this reviewer, who has constructed over 300 atomic, molecular, and solid state models using both radii without any of the difficulties mentioned in this book.

In addition to the one chapter of model construction, there are nine chapters on possible uses of the models to explain the properties of various substances. There is a useful bibliography of articles on model building from the *Journal of Chemical Education* and 55 pages of tables giving the dimensions and other data necessary for the construction of the Sanderson type models. The book also contains 16 pages of black and white photographs and a like number of pages of color plates which probably contributed to the relatively high cost of this small volume.

It is the hope of this reviewer that teachers who use the Sanderson and other types of models will stress the many limitation and dangers of over-emphasizing the use of models in teaching so that their students will not be carried away by the glib accounts of their usefulness that characterize many of the articles written by model building enthusiasts.

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Mathematical Crystallography and the Theory of Groups of Movements. By HAROLD HILTON. Dover Publications, Inc., 180 Varick St., New York 14, N. Y. 1963. xii + 262 pp. 13.7 × 21.6 cm. Price, $2.00.

A review of this book was originally published in the *Philosophical Magazine*, **7**, 605 (1904), and some of the reviewer's comments are still appropriate today.

"Crystallography is a science which in its practical aspect concerns the mineralogist and the chemist; but very few of those who are familiar with the forms and classifications of crystals will find Mr. Hilton's pages easy reading."

"The book is . . . . a treatise on the theory of a set of finite groups of a special type, involving certain operations of translation, reflexon, and rotation."

"The argument is frequently very condensed, and every line demands the closest attention on the part of the reader if he really wishes to follow the demonstration. . . . There is a steady strain upon the geometrical and kinematical imagination, a strain which comparatively few of those who are practically interested in crystallographic questions will care to undergo."

The listing of point groups, space groups, and their subgroups and equivalent points are, of course, more adequately presented in the modern "International Tables for X-Ray Crystallography." There are also a number of modern books presenting the applications of symmetry groups to crystallography which should be preferred by a student of crystallography. Another style of presentation is always valuable for deeper insight, however, and a modern reader may be intrigued by the extent of the development of the symmetry concepts before von Laue's discovery of the X-ray diffraction phenomenon and the present

day knowledge of crystal structures. This book provides such an early account in the English language, as its purpose at the time was to provide an English language source of much that had been published in German or other languages.

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Crystallographic Data on Metal and Alloy Structures. Compiled by A. TAYLOR and BRENDA J. KAGLE. Dover Publications, Inc., 180 Varick St., New York 14, N. Y. 1963. 263 pp. 13.5 × 20.3 cm. Price, $2.25.

In reviewing this compilation of crystallographic data, it is natural to compare it with the contents of Pearson's "Handbook of Lattice Spacings and Structures of Metals and Alloys" upon which it is heavily based. The new compilation presents only the structure type, space group, cell dimensions, and for some phases the three prominent *d*-spacings and the relative line intensities from the ASTM Powder Data File. References, atom positional parameters, and other experimental details are not given. Hence, the compilation is an updated version of Tables 7, 8, and 9 from Pearson's book.

A spot comparison made at several randomly selected points in the book revealed that Pearson's data compilation had been extended by some 10 to 20%. Errors were detected, however, in this relatively small sample. For example: $AgGaTe_2$, with a listed as 6.288 kX. in Pearson, is converted to 6.3007 Å., giving the impression of added precision which is unjustified. The conversion of kX. to Å. of c for the tetragonal form of $AgInS_2$ seems to be in error. The data on β-AgMg also disagree. Again, an error seems to have been made in the conversion of a for $CePt_2$. Pearson gives 7.714 kX., but Taylor and Kagle list 7.188. (This latter appears to be the conversion of 7.174.) Since it is unlikely that the few randomly sampled pages contain the only errors in the book, the user must beware in placing too much reliance on the values given.

The phases are not listed in a completely alphabetical fashion. As a result, any given phase must be searched for under all of its components. It would have been more useful to replace the catalog of Dover books at the end of the book with a summary of the atom positions and typical parameters of the various structure types.

The authors' intent of a compact low-cost summary of intermetallic phase data was an admirable one. It is too bad that it was defeated by errors and poor arrangement of data.

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Physical Inorganic Chemistry. By MICHELL J. SIENKO and ROBERT A. PLANE. W. A. Benjamin, Inc., 2465 Broadway, New York 25, N. Y. 1963. ix + 166 pp. 15 × 22.7 cm. Price, cloth, $7; paperback, $3.95.

This small book is one of the latest additions to the growing list of inorganic texts and monographs which have appeared in the past several years. Its purpose is evidently to present the basic principles of inorganic chemistry by applying physical concepts to inorganic systems. The list of topics covered—atomic and molecular structure, solid state chemistry, liquids and solutions, chemical kinetics and mechanisms—justifies the title. The coverage of all of these topics is very brief, in fact too brief to allow this book to have any real value as either a text for beginners or a reference for those who have only rudimentary knowledge of these topics and desire a somewhat more detailed presentation. Indeed, the principal question which has remained with this reader after completing the book relates to its real utility and purpose. Judging from the Preface the function of this book is to serve as a general introduction for topics which have been or will be covered in specialized monographs in the Benjamin Physical Inorganic Chemistry Series. Considering those several monographs currently available in relation to the coverage of the appropriate topics in this volume, there seems to be no point in consulting this volume in the first place. In summary, the brevity and lack of depth apparent in the exposition of the above topics renders this book unsatisfactory as a textual source for these topics, which are covered on an introductory or advanced level far more satisfactorily elsewhere.

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The Chemistry of the Lanthanides. By T. MOELLER. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y. 1963. ix + 109 pp. 12 × 18.5 cm. Price, $1.95.

The value of this paper-backed monograph is rather difficult to assess. Certainly its five chapters contain a wealth of essential facts of interest to most chemists, and it is written in a clear, concise, and interesting manner. The specialist in the lanthanide series will, however, be disappointed in its lack of depth, since it embodies only that information one would expect, but does not always find, in a general treatise on inorganic chemistry. Perhaps this is exactly what the author had in mind. In view of a rapidly developing technical interest in applications of rare earths, all candidates for the Ph.D. degree in chemistry should be informed regarding rare earths to approximately the level indicated in this booklet.

At the end of the monograph, the author has appended a 14-page account of the actinide elements which appears to be entirely proper and of some merit.

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BOOKS RECEIVED

May, 1964

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KAZUNOBU KODAMA. "Methods of Quantitative Inorganic Analysis." John Wiley and Sons, Inc., 605 Third Ave., New York 16, N. Y. 1964. xiv + 507 pp. $22.

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J. W. MELLOR. "Supplement to Mellor's Comprehensive Treatise on Inorganic and Theoretical Chemistry, Volume 8, Supplement 1, Nitrogen Part 1." John Wiley and Sons, Inc., 605 Third Ave., New York 16, N. Y. 1964. lxviii + 619 pp. $50.

GIUSEPPE BRUNI. "Chimica Generale e Inorganica." 12th Ed. Tamburini Editore, Milan, Italy. 1964. xxii + 724 pp.

CLARENCE A. DISCHER. "Modern Inorganic Pharmaceutical Chemistry." John Wiley and Sons, Inc., 605 Third Ave., New York 16, N. Y. 1964. xii + 636 pp. $12.

WILLEM BROUWER. "Matrix Methods in Optical Instrument Design." W. A. Benjamin, Inc., 2465 Broadway, New York 25, N. Y. 1964. xi + 290 pp. Clothbound, $9; paperback, $5.95.