also but a minor component of the subtropical Tampa and Mobile Bay sediments, a function probably of river discharge and reduced salinity. The use of calcite as a climatic indicator is clearly of great subtlety.

D. C. Krause fills in the semidetailed study of the Southern California continental borderland begun by Shepard and Emery a quarter century ago. Most interesting are his excellent underwater photographs, showing tracked surfaces, at 1935 and 3550 meters, which palichnologists would probably classify as most likely shelf features.

No one would expect all papers in such a volume to be of equal quality or verbal parsimony, and they are not. It is an organizational defect that they do not have abstracts or summaries to help in sorting them out. Of the typographical errors noted, only one is important—the photograph, Fig. 24.4B, was taken in 1918, not 1910, and looks north, not south.

Leaving quibbles aside, Fran Shepard can well be proud of his book, his boys, and himself. Many who were not his former students join in wishing him well in retirement.

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Inorganic Chemistry

Non-Stoichiometric Compounds. L. Mandelcorn, Ed. Academic Press, New York, 1964. xiv + 674 pp. Illus. $22.50.

At the end of the 18th century, the general discussion between Berthollet and Proust led to the conception that chemical compounds have a constant composition, and on this basis the general development of chemistry has proceeded. But at the end of the 19th century, when investigations concerning the mutual behavior of metals were carried out, many examples of intermetallic phases with broad "homogeneity ranges" were stated. In the meantime we have discovered "nonstoichiometric" compounds—solid substances of very different character. How manifold the fields concerned are is demonstrated in this book, edited by L. Mandelcorn. The volume contains the following chapters: (i) "X-ray structural analysis" (J. M. Robertson, 46 pages); (ii) "Statistical thermodynamics and reaction rate theory" (D. Henderson and H. Eyring, 46 pages); (iii) "Inorganic non-stoichiometric compounds" (A. D. Wadsley, 103 pages); (iv) "Occluded gases in transition metals" (O. M. Katz and E. A. Gulbransen, 51 pages); (v) "Physical properties of nonstoichiometric inorganic compounds" (C. Subbarao, 38 pages); (vi) "Inorganic inclusion complexes" (R. M. Barrer, 121 pages); (vii) "Clathrates" (H. M. Powell, 52 pages); (viii) "Organic adducts" (L. C. Fetterly, 73 pages); (ix) "Carbohydrates" (F. R. Senti and S. R. Erlander, 35 pages); and (x) "Physics and chemistry of inclusion complexes" (L. A. K. Staveley, 29 pages).

In general, the different chapters are well written and provide a good introduction to the different fields. Predominant emphasis is given to structural questions; indeed, the existence of many nonstoichiometric compounds is understandable only on the basis of structural pecularities. On the other hand, more detailed structural investigations have demonstrated that in some cases the assumed nonstoichiometry does not exist, but that a great number of stoichiometric compounds of very similar, although complicated, structures are present. The discussion of the properties of the substances is a bit brief. And some other chapters should have been enlarged. Why is the otherwise well-written chapter 3 restricted to oxides and other chalcogenides? A treatment of halogenides, phosphides, and the like, and especially of nonstoichiometric intermetallic compounds, would be most interesting. The same is true with respect to chapter 5, and in chapter 4 one is disappointed to read only of hydrides. In a second edition, chapters 3, 4, and 5 should be enlarged.

In general this book is very useful and can be recommended.

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Optical Methods of Analysis

Treatise on Analytical Chemistry. Part 1, Theory and Practice. vol. 5, *Optical Methods of Analysis.* I. M. Kolthoff and Philip J. Elving, Eds. Interscience (Wiley), New York, 1964. xx + 640 pp. Illus. $16.

This fifth volume in part 1 of the *Treatise on Analytical Chemistry* represents the first of two volumes that will be devoted to optical methods of analysis. Edward J. Meehan assisted the editors as section adviser. Individual chapters include "Optical methods: Emission and absorption of radiant energy," "Fundamentals of spectrophotometry," and "Spectroscopic Apparatus and Measurements," all by Meehan; "Principles of light scattering" by Fred W. Billmeyer, Jr.; "Specification and designation of color" by D. B. Judd and I. Nimeroff; "Ultraviolet and visible spectrophotometry" by Alfred A. Schilt and Bruno Jaselskis; "Fluorometry" by Anne L. Conrad; "X-ray methods: Absorption diffraction and emission" by H. A. Liebhafsky, H. G. Pfeiffer, and E. H. Winslow; "X-ray microanalysis by means of electron probes" by David B. Wittry; "Microwave spectrophotometry" by J. H. Goldstein, and "Nephelometry and turbidimetry" by Frank P. Hochgesang. Generally, the chapters are well written and contain a minimum number of typographical errors. This volume follows the format of earlier volumes of the *Treatise.*

Although it is a difficult task for an editor to integrate a collection of chapters written by different individuals into a coherent presentation, I feel that the volume could have been better organized. For example, optical components of instrumentation (prisms, gratings, and so forth) are discussed in chapter 55, but light sources and detectors are dealt with in the second part of chapter 58. Interposition of chapters on light scattering (chapter 56) and specification of color (chapter 57) between fundamentals of spectrophotometry (chapter 54) and ultraviolet visible spectrophotometry (chapter 58) hardly seems desirable. Also, there appears to be undue repetition and fragmentation of topics between chapters. For example, Tables 53.I and 58.I are essentially identical. Atomic transitions, the Beer-Lambert law and derivations from it, precision spectrophotometry, and spectrophotometric analysis of mixtures are all treated, to varying degrees, in more than one place.

The volume is not without serious technical errors and omissions. In the consideration of environmental effects on ultraviolet absorption spectra (p. 2955 *et seq.*), no mention is made of the *p*H-dependency of spectra for molecules containing acidic or basic groups. The statement is made that ". . . a double monochromator cannot be used with a single vacuum phototube" (p. 3006), even though several commercial spectrophotometers employ such an arrangement. The discussion of the effect of sample fluorescence on absorption spectra is confusing. The author makes the rather ambiguous statement that the fluorescence ". . . will appear in the absorption spectrum . . ." (p. 3031). He also states that, if one wishes to record a fluorescence spectrum, the source of excitation should ". . . be placed as close to the detector as possible . . . ," but such placement is contrary to good design principles. In the discussion of ways to correct absorption spectra for fluorescence artifacts, no mention is made of the obvious, and the best, technique of using two monochromators.

Probably the most serious technical errors in the volume are in chapter 59, "Fluorimetry." The author implies (on p. 3058) that fluorescence and phosphorescence are often confused at room temperature when, in fact, almost no compounds phosphoresce at room temperature. In the discussion of Fig. 59.1 it is implied that the quantum yield of fluorescence depends on the ratio of energy lost by internal conversion to the lowest excited singlet state, to the energy emitted as fluorescence. For most molecules the quantum yield is independent of the state to which it was initially excited, but is governed by the relative rates of spontaneous emission from the vibrationally unexcited lowest singlet state and competing processes. In Fig. 59.1 two lines are said to represent phosphorescence emission, whereas one (line 5) represents phosphorescence and the other (line 6) a radiationless transition from the lowest triplet state to the ground state. On page 3061 the lifetime of an excited singlet state is given as 10^{-12} sec, but 10^{-9} to 10^{-7} is more accurate. The statement is made that, at liquid nitrogen temperature, the decay rates of emission are increased (p. 3062). Actually, the rate of emission is relatively independent of temperature, but the rates of competing processes are reduced at 77°K, relative to room temperature, so that an excited state may come closer to its intrinsic lifetime which generally is *longer* than that observed at room temperature. The discussion of filter fluorometers (p. 3070 *et seq.*) fails to include two of the most popular filter fluorometers, the Farrand and Turner instruments. Finally, of the 157 references cited for chapter 59, only four are more recent than 1958.

Although there are some excellent chapters in this volume which will allow it to serve as a valuable reference work for some areas of analytical chemistry, the volume as a whole is not up to the high standards established by volumes 1 and 2 of part 1 of the *Treatise*.

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Cal Tech Lecture Notes

Mathematical Methods of Physics. Jon Mathews and R. L. Walker. Benjamin, New York, 1964. xii + 475 pp. Illus. $12.50.

There is no reason to deplore the proliferation of textbooks for the 1-year course on mathematical methods which is commonly taught to beginning graduate students, since the content and the level of sophistication of this course vary greatly from school to school. Unlike some other graduate courses in physics, this course cannot follow a uniform pattern. It must be related to the background of students and to their anticipated needs as they prepare for particular areas of research.

In the long chain of books on mathematical methods, the classic work of Courant and Hilbert stands at one extreme as a most comprehensive, systematic, and mathematically satisfying treatise. The volume reviewed here occupies the other extreme. It is designed to teach almost entirely by precept and example, as mathematical problems from contemporary physics are posed and methods for their solution developed. The emphasis throughout is on expeditious manipulation and speedy acquistion of mathematical skill for work in physics.

In the interest of getting things done, Mathews and Walker have gone as far as possible in the direction of teaching the tools of the trade. Remarkably, they have not sacrificed precision in the process, but there is no pretense of mathematical rigor, and most proofs are omitted. The result is occasionally incongruous. For instance, some secondary, although admittedly useful, theorems about group characters are derived, but several "very important theorems about group representations," including Schur's lemma, on which these derivations depend, are stated without proof. In lecturing, this kind of compromise is necessary and proper; however, I consider it the purpose of a useful textbook (and not only of a reference work, as the authors suggest) to supply the material in reasonably comprehensive form, including essential proofs.

The book by Mathews and Walker, then, is not so much a textbook as an excellent set of lecture notes, intended to tell us how the course is taught at California Institute of Technology. When we examine it in this light, the reservations evaporate. The choice of material is sensible. In addition to the standard topics on ordinary and partial differential equations, linear vector spaces and matrices, Green's functions and integral equations, and special functions and tensor analysis, it includes some calculus of variations, a chapter on numerical methods, another on probability and statistics, and an introduction to groups, already mentioned. The pace of the course is merciless, but for those who work the numerous problems and abandon themselves to the pragmatic spirit of the book, the study is bound to be rewarding.

The suitability of *Mathematical Methods of Physics* for use in a graduate course will depend on the taste and outlook of the instructor. If he likes to teach the course his own way, but wants to refer his students for detail and elaboration to a systematic textbook, other treatments are preferable; on the other hand, if he is interested in "following" a book, the Cal Tech course, carefully worked up as it is, can be highly recommended. But whether he wants to assign the book to his students or not, the instructor will find it a refreshing source of ideas and examples from which to draw for his pedagogic equipment.

The range of topics which the book treats in comparatively short space is truly astonishing. From the WKB connection formulas to dispersion relations, from the Wiener-Hopf method to the central limit theorem, from a graphical representation of the Fredholm solution to SU(3), there is a wealth of mathematical techniques, all of it of current interest in physics.