has made quite a dent in this complex problem, in particular his contributions concerning the stability aspects. It is perhaps in this area of time-varying systems that the flow of information and ideas may be from the control engineer to the networks designer.

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The Theory of Transition-Metal Ions. By J. S. GRIFFITH, Professor of Chemistry, University of Pennsylvania; Berry-Ramsey Fellow in Mathematics, King's College, Cambridge. Cambridge University Press, 32 East 57th Street, New York 22, N. Y. 1961. h + 455 pp. 18 × 26 cm. Price, $17.50.

No field of chemistry has in the last decade been any more exciting in its decisive conquest of old problems, its development of new ideas, and its rise to new levels of sophistication than the chemistry of the transition elements, especially their coördination chemistry. This revolutionary surge of vigor is due in considerable part, as practically everyone knows, to the rediscovery and practical extension by chemists of those theories developed by physicists such as Bethe, Schlapp and Penney and most particularly J. H. Van Vleck during the 1930's. Known today in its various interrelated forms as crystal field theory or ligand field theory, it provides a powerful conceptual framework and, *mirabile dictu*, computationally practical tools for the solution of many problems of spectroscopy, magnetism, bonding, structure, reactivity and thermodynamic stability of transition metal compounds and complexes.

But for the chemist to use this new power he must pay a price. That price is the acquisition of some more difficult and sophisticated physics and quantum mechanics than he perhaps ever thought would be necessary for a chemist. Rapid as it may have seemed in the last decade, the spread of the ideas and techniques of ligand field theory has not been as rapid as it might have been because the lack of textbooks, on any level, inflated this price beyond the resources of many.

It seems to this reviewer that for several years the need has existed for three different books. For those whose goal (not necessarily their final one) is acquaintance with the important qualitative ideas and pictorially expressed concepts and the relationship of these to the better known experimental facts, a short catechistic book putting emphasis on results rather than reasons and principles is required. This need has recently been met by L. E. Orgel's articulate monograph. On the next level, one would desire a book covering basic principles and quantitative techniques written for the willing but mathematically untutored and undistinguished chemist—in short, a practical but unpretentious book. Regrettably, no such book yet exists; it is to be hoped that one will appear soon. Finally, there has been a need for a mathematically sophisticated and rigorous book presenting "a unified and deductive introduction to that part of theoretical physics...known as ligand-field theory" and directed "primarily to mathematical physicists and theoretical chemists." This last book, described in the preceding sentence partly by quotations from its preface and its dust-jacket, has now been written, and very masterfully written indeed, by J. S. Griffith.

After a brief introduction apparently intended for physicists who know absolutely no chemistry for whose benefit, apparently, the book is also graced with a table of the names, atomic numbers and symbols of the elements), the book proceeds to some chapters *ostensibly* directed to chemists who know no physics. However, in the first of these chapters which cover relatively elementary considerations of angular momentum and electronic structure of atoms, the author remarks that while he "starts from the beginning" (which is true) "it is rather desirable that the reader should possess already a little knowledge of quantum mechanics: §§ 1–22, 27, 42 and 43 of Professor Dirac's book *Quantum Mechanics* probably cover all that is really necessary." Thus these chapters cover what a chemist knowing no physics would have to learn before tackling ligand field theory *per se* but it seems no small understatement to say that these chapters would be a very formidable challenge for the true neophyte. These remarks will serve, I hope, to convey a lively impression of the general level of sophistication of the entire book.

Following the chapters (2–5) on atomic structure there is an elegant chapter on group theory, only marred in spots by the unfortunate confusion of the terms symmetry element and symmetry operation. Beginning with Chapter 7, ligand field theory *per se* is developed brilliantly and incisively in three longish chapters. Chapter 10 gives a whirlwind resume of magnetic susceptiblity theory including post-Van Vleck developments such as Kotani's method and the author's own ingenious modification of it. Chapter 11 presents a relatively non-mathematical discussion of the optical spectra of complexes and should be of interest to many chemists, even those who would not get much benefit from earlier chapters. The final chapter is a rather long and thorough one on paramagnetic resonance, covering both theory and representative examples of its application. The book closes with 68 pages of appendices most of which are tabulations of data, formulas and matrix elements useful in performing computations. While this reviewer did not attempt to check these tabulations for accuracy, if one makes the likely assumption that they are relatively free of errors, it can be said that they constitute an extremely valuable feature of the book.

The author has entirely omitted discussion of the f^n configurations.

The entire book has the distinguished format typical of Cambridge University Press publications and in over four months on my shelf in muggy Massachusetts the covers have not buckled as covers on English books so often do. It has lately become one of the most tiresome cliches of book reviewers to note in closing how outrageously a book is priced—right out of reason and reach. In the present case, I can happily make just the opposite observation: this book seems to me to be worth every bit of the $17.50 that is asked for it.

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