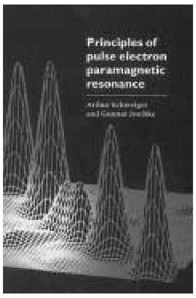
plishments, it is refreshing to read an autobiography which shows that nice guys don't always finish last.

William C. Trogler
University of California, San Diego
La Jolla (USA)

Principles of Pulse Electron Paramagnetic Resonance. By *Arthur Schweiger* and *Gunnar Jeschke.* Oxford University Press, Oxford 2001. 578 pp., hardcover £ 95.00.—ISBN 0-19-850634-1

Principles of Pulse Electron Paramagnetic Resonance is a new textbook by Schweiger and Jeschke on one of the most important recent developments in electron paramagnetic resonance (EPR). The time lag between NMR and EPR with respect to the use of pulsed techniques is largely due to instrumental factors related to the faster relaxation of electron spins compared to nuclear spins, but improvements in microwave equipment have brought pulsed EPR within reach for widespread use, and pulsed EPR spectrometers have recently become commercially available. Previously, pulsed EPR was more or less the exclusive domain of groups dedicated to instrumental and theoretical development. With the technical obstacles removed and an increasing number of successful applications demonstrating the potential of pulsed EPR, interest in pulsed techniques grew, but a deficit in theory became obvious: the classical EPR textbooks focus on continuous wave (cw) EPR, and pulsed techniques are only mentioned as a side issue. In the pre-Schweiger–Jeschke era, the sources for learning about pulsed EPR were limited to the original publications, several review articles and compilations of articles in books, and one monograph on electron spin echo envelope modulation (ESEEM).[1]



Therefore, a textbook that would fill the gap was sought in the EPR community. The book by Schweiger and Jeschke is designed to fill that gap, and it presents a new approach compared to the traditional EPR textbooks. Roughly the first half of the book is devoted to theory and background. Here a consistent use of the vector picture, a lucid introduction to the concept of phase, and careful explanations of how the applied pulses relate to the laboratory reference frame and the rotating frame, help the reader to understand how a sequence of microwave pulses affects the spin system. The product operator formalism is introduced for the first time in an EPR textbook. The description is clear and the physics behind the equations is spelled out. Figures illustrate the relevant points, and they often aid significantly to the understanding. Many of the figures appear for the first time in a textbook, and the authors have succeeded in selecting the most illustrative and didactic figures that have appeared in the original literature. Many simulations also help the reader to understand specific aspects.

But theory is not all, and, based on the authors' considerable experience, the book covers practical aspects thoroughly, including limitations and possible pitfalls of specific methods. These include the effects of the limited excitation bandwidth of the pulses, a notorious problem in pulsed EPR. The effects of such imperfections on the spectra, which can vary depending upon the nature of the experiment, are described. Also, in contrast to a purely theoretical approach, in many instances real examples with numerical values are given, offering the reader an opportunity to work with the equations using practical examples. All constants and symbols are listed, and SI units are used throughout.

A major portion of the second part of the book is devoted to techniques for determining hyperfine interactions between the electron and nuclear spins. Hyperfine interactions are an important signature of the electronic structure of paramagnetic centers, since they can be related to MO coefficients, and often allow one to determine the number and type of ligands surrounding a metal center. Beginning with the ESEEM method, the full arsenal of hyperfine selective techniques is discussed, including various pulsed electron–nuclear double resonance (ENDOR) methods.

As well as techniques for determining hyperfine interactions, the authors describe more or less all the currently relevant types of experiments in pulsed EPR, adding some that are currently being developed (although that distinction is not always clearly spelled out). Electron–electron double resonance (ELDOR) techniques are described in Chapter 13, as well as nutation spectroscopy, etc. While all these applications can be found in the literature, the detailed description in the book makes them much more understandable.

In Chapter 17 the factors that enter into the choice of the optimum field–frequency combination to perform a specific EPR experiment are described. This is an important issue in EPR, and from the discussion and the examples it becomes clear that the optimum can only be found by taking into account the field dependence of all relevant magnetic interactions in a given paramagnetic center, including, for example, that of the major relaxation mechanisms.

Towards the end of the book there are several chapters summarizing various recent developments (e.g., Chapter 16). Perhaps owing to their diversity, some of the didactic approach that makes the preceding chapters so appealing is missing here.

The final chapter of the book (Chapter 18) is a daring attempt to demonstrate a systematic approach to determining structure from EPR parameters. It seems unlikely that such an ambitious goal can be attained, and Section 18.1, perhaps inadvertently, confirms these doubts. It sounds like seeking the EPR equivalent of a universal guideline on how to synthesize any conceivable organic compound. Nevertheless, Chapter 18 is an excellent summary of practical conclusions drawn from the individual techniques. Especially where the authors re-enter their home ground and discuss procedures for determining the type and number of nuclei from hyperfine spectroscopy (Section 18.2.4), they give a clear outline of strategies and a systematic approach to deciding which techniques to use.

So, does this book fill the gap mentioned above? Obviously, the answer is affirmative. Will the book replace the

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existing EPR textbooks? For two reasons, that does not seem likely. First, the extensive information that other textbooks provide about the properties of paramagnetic centers such as organic radicals[2,3] or transition-metal ions[2,4] is something EPR spectroscopists cannot do without. Secondly, the theory is not easy to assimilate on one's first exposure to EPR. So, we hold our breath to see a new generation of students who, after "a month in a mountain hut" with the book (see preface), will come back with a working knowledge of pulsed EPR. Nevertheless, we may still be tempted to give them a copy of Atherton's book[2] as they leave.

[1] S. A. Dikanov, Y. D. Tsvetkov, *Electron Spin Echo Envelope Modulation (ESEEM) Spectroscopy*, CRC Press, Boca Raton, **1992**.

[2] N. M. Atherton, *Electron Spin Resonance*, Ellis Horwood, New York, **1993**.

[3] J. A. Weil, J. R. Bolton, J. E. Wertz, *Electron Paramagnetic Resonance*, John Wiley & Sons, New York, **1994**.

[4] J. R. Pilbrow, *Transition Ion Electron Paramagnetic Resonance*, Oxford University Press, Oxford, **1990**.

Martina Huber
Huygens Laboratory, MAT Group
Leiden University
Leiden (Netherlands)

Instruments and Experimentation in the History of Chemistry. Edited by *Frederic L. Holmes* and *Trevor H. Levere.* (Series: Dibner Institute Studies in the History of Science and Technology). MIT Press, Cambridge, MA 2000. xxi + 415 pp., hardcover $ 50.00.—ISBN 0-262-08282-9

Although, from the earliest beginnings of alchemy to the present day, chemistry has been and continues to be primarily an experimental science, historians have concentrated on the development of chemical theory rather than on the instruments and experimental techniques through which its theories have advanced. A notable exception is provided by *The History and Preservation of Chemical Instrumentation* (edited by John T. Stock and Mary Virginia Orna, published by D. Reidel, Dordrecht/Boston/Lancaster/Tokyo 1986), a collection of papers presented at a symposium on the subject held at the 190th National Meeting of the American Chemical Society, Chicago, Illinois, September 1985). A welcome addition to this sparse genre is another collection, consisting of 14 essays by 14 distinguished historians of science from the United States (7), Canada (2), France (1), and the UK (4), edited by Frederic L. Holmes, Avalon Professor and Chairman of the Section of the History of Medicine at Yale University, and Trevor H. Levere, Professor of the History of Science at the Institute for the History and Philosophy of Science and Technology, University of Toronto.

From its beginnings in the work of alchemists and practical artisans, chemistry has been defined by the instruments and apparatus which comprise a repertoire of laboratory operations that its practitioners have used to examine naturally occurring materials or the fabrications of human culture. Therefore historians of chemistry have always been concerned with activities involving instruments and experiments. However, that concern has usually been overshadowed by their primary attention to such subjects as the origins, structures, and transformations of theory or to the careers of chemists and the institutional organizations in which these careers were built. The aim of this book by Holmes and Levere is "simply to move the instruments and experiments into the foreground of our concern". The principal themes are stability and change, precision, the construction and transformation of apparatus, the dissemination of instruments, and the bridging of disciplines by means of instruments.

One of the main reasons for the historical neglect of chemical instruments and apparatus has been the lack of material evidence, for most of the items are disposable and have been made of breakable glass, earthenware, or stoneware. Furthermore, they are rarely signed or beautiful, so they seldom appeal to collectors, in contrast to astrolabes or microscopes. Consequently, whatever has been preserved in laboratory basements or museums is neither comprehensive nor representative. For example, from the laboratory of so eminent and historically significant a chemist as Lavoisier, less than one percent of its original 6000 items of glassware has survived.

The book is divided into three sections arranged chronologically. Section I, "The Practice of Alchemy" (74 pp., three chapters) considers material and iconographic evidence, the written record, and the question of reproducibility. In "The Archaeology of Chemistry" (30 pp.) Robert G. W. Anderson* (asterisks denote recipients of the Dexter Award in the History of Chemistry) explores the range of material evidence for chemical experiments and practices in the ancient and medieval world. In "Alchemy, Assaying, and Experiment" (20 pp.) William R. Newman uses the written and pictorial record to argue for the continuity of practice as Anderson does for the archaeological evidence. In "Apparatus and Reproducibility in Alchemy" (20 pp.) Lawrence M. Principe employs dramatic and apparently allegorical imagery to extend our understanding of the common ground between alchemy and chemistry.

Section II, "From Hales to the Chemical Revolution" (163 pp., the largest section, 6 chapters) shows how chemists sought to distance themselves from discredited alchemical practice although they continued to use instruments, apparatus, and operations that they had shared with alchemy. By the end of the 18th century the chemical laboratory, which had remained relatively unchanged for more than two centuries, was evolving into a rapidly changing workplace. In "Slippery Substances: Some Practical and Conceptual Problems in the Understanding of Gases in the Pre-Lavoisier Era" (26 pp.) Maurice Crosland* argues that, although Stephen Hales's invention of the pneumatic trough in 1728 was a turning point in enabling chemists to deal with "airs" and vapors, its manipulation alone could not lead to the identification of the gaseous state. In "Measuring Gases and Measuring Goodness" (36 pp.) Trevor H. Levere discusses the advent and refinement of early eudiometers and gasometers.

In "The Evolution of Lavoisier's Chemical Apparatus" (16 pp., the shortest essay) Frederic L. Holmes* shows that the experiments by which the "father of modern chemistry" developed his new and revolutionary theories were carried out with relatively simple appa-

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