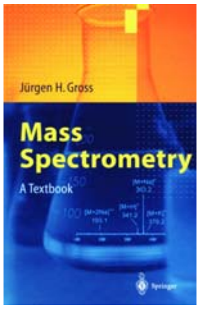
technique is often the last in a long line of chemical or physical analyses. In other words, mass spectrometry is tailored to the research; it is the tail wagged by the dog.



Physics, chemistry, biochemistry, and all their various subdisciplines find their way into the general topic of mass spectrometry. Sorting out this diversity in a suitably pedagogic way is hardly trivial. Although monographs on various aspects of the subject are available, as are thousands of published papers regarding its applications to particular problems or sets of problems, no textbook existed, to my knowledge, that offered an integrated perspective. Even Jürgen Gross realized, as he states in his preface to *Mass Spectrometry: A Textbook*, that "the ideal textbook still seemed to be missing." But maybe that statement is no longer true: Gross's textbook comes close to the ideal.

Gross does two important things in his book. First, he admittedly focuses on organic mass spectrometry—which is by no means a shortcoming. In terms of samples analyzed and the diversity of analyses, organic mass spectrometry vastly overwhelms all other applications combined. Moreover, various aspects of it have direct applications to inorganic analyses.

The second important aspect of Gross's work is that he organizes the text so that the fundamental and underlying elements of the field are discussed evenly and in detail in the first four chapters. Electron ionization and gas-phase ion chemistry are covered in the fifth and sixth chapters. The fundamentals are subsequently woven into discussions of various ionization methods. Anyone who would be a mass spectrometrist would do well to study the first six chapters in depth.

Chapters 7 through 11 can each be viewed as a standalone. The chapters are based on the principles of mass spectrometry addressed in the first five chapters, and each discusses a specific ionization method. Methods covered include chemical ionization, field ionization and desorption, fast-atom bombardment, matrix-assisted desorption and ionization, and electrospray ionization. The methods, in modern practice, result largely from bimolecular processes and lead to the formation of pseudomolecular ions, such as protonated molecules. The relative abundance of the ions, their fragments, and their adducts is the stuff of modern mass spectrometry. Yet each ionization method is different, characterized by its own protocols for sample preparation, loading, mass dispersion, mass spectral analysis, optimal instrumentation, and artifacts and pitfalls. Gross describes and contrasts the characteristics of each method clearly and in detail.

Gross's consistent yet familiar and engaging style is educational, and the text is effectively integrated with graphics and diagrams—some 357, according to the title page. These photographs and diagrams address a range of topics, from tentatively identified compounds and reconstructed ion chromatograms, to fragmentation energetics, ion trajectories, and mass-spectrometer source design. The author uses well-placed, framed text-boxes to provide summaries, add technical and historical notes, address peculiarities, and give pointers. The approach is endearing, especially for students in the lab who would otherwise be left wondering why the mass spectrum did not turn out the way the book said it should.

Mass Spectrometry could easily serve as a laboratory handbook. Every chapter is exceptionally well documented, with up to 200 appropriate and current literature citations. To someone working in the field, such citations are invaluable. In addition, at the end of each chapter, Gross summarizes the effectiveness of each ionization method for compound class, polarity, and molecular weight. The book also contains what might be called anecdotal sections. For example, the brief section on buying an instrument is alone worth the price of the book. Although it is unlikely that a senior undergraduate or graduate student would be purchasing a mass spectrometer, timely reference to this section in a working laboratory would prevent any number of future headaches.

The final chapter, "Hyphenated Methods," represents a paradigm shift. It is not about an ionization method at all but about combining separation with mass spectrometry. Coupling the gas chromatograph to the mass spectrometer was a monumental accomplishment 40 years ago. However, by the time a sample is run by gas chromatography–mass spectrometry (GC/MS), the mass spectrometry is pretty much a formality and chromatography becomes the main issue. Although the final chapter conveys the information necessary for a textbook, it lacks the enthusiasm generated by earlier chapters; that lack clearly reflects the fact that Gross is, after all, a mass spectrometrist, and subjects like GC/MS are fairly tame.

The book could have benefited from an expanded discussion of automated mass-spectral data handling, or perhaps even an added chapter. Mass spectrometers can generate data at a ferocious rate that necessitates automated methods, and the programs are commonplace. Currently, for example, there are at least 25 000 mass spectrometers that use automated search and retrieval systems for electrospray ionization spectra alone. Moreover, without automated analyses of mass spectra obtained from protein and DNA samples, the spectra would be practically useless: They simply contain too many peaks. Data retrieval and automated interpretation intrinsically fall into the domain of computer programming, but the programs were developed by mass spectrometrists using the very approach discussed in this book. In order for Gross to be consistent with the rest of the book, a discussion of the logic of these programs seems appropriate.

Taken as a whole, *Mass Spectrometry* is simply excellent. The book not only removes the label "black box" from the mass spectrometer but also conveys overall what might be termed as the central core of the philosophy of the mass spectrometrist. Many espouse the notion that mass spectrometry can be applied to analytical problems ranging from the obvious measurement of isotope ratios to the more subtle determination of the tertiary structure of proteins. If a problem isn't solved, it simply isn't solved *yet*. Scientists reading Gross's book as students, teachers, or practitioners will understand why mass spectrometrists are so optimistic.

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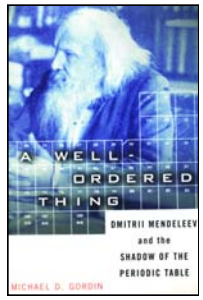
A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table

Michael D. Gordin
Basic Books, New York, 2004.
$30.00 (518 pp.).
ISBN 0-465-02775-X

In March 1869, when Dmitrii Mendeleev (1834–1907) was in the thick of work on his periodic system of the chemical elements, he left St. Petersburg, Russia, to visit cheese dairies in the countryside. Coming back, he lectured to students at the University of St. Petersburg on the breeding of dairy cattle and the analysis of soil on experimental fields. Far from devoting time and energy exclusively to the solution of vexing theoretical and taxonomic problems, Mendeleev was fascinated with agricultural reform and the social and political modernization of his country. He was 35 years old, and his ambitions were not satisfied by restructuring chemical science. He also dreamt of a new, unified, and rational Russian empire, and would continue to do so his entire life.

Like other Russian intellectuals, Mendeleev wholeheartedly supported the so-called Great Reforms of Tsar Alexander II that began in 1861. Rational and consensual decision making in science became the model for fundamental social reform in imperial Russia. Chemists, in particular, provided useful expertise for the reforming state to improve agriculture and industry. While Michael Gordin's engaging book, *A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*, follows Mendeleev's scientific career, it also vividly depicts the man's many political, economic, and social endeavors. He consulted for the Baku oil industry in the 1860s and 70s, fought against spiritualism in the 1870s, became director of the Chief Bureau of Weights and Measures in 1893, and contributed to the introduction of the metric system for optional use in Russia in 1899. Gordin's narrative is at once a biography of a multifaceted man; a history of imperial Russia from the beginning of the Great Reforms to the revolution of 1905; an intriguing case study of the entanglement of science, industry, and politics in the 19th century; and a history of 19th-century chemistry and physics. As far as I know, Gordin's book is the most comprehensive biography in English about Mendeleev.

Gordin's narrative starts with a historical reconstruction of Mendeleev's major scientific achievement—the natural periodic system of chemical elements and periodic law. Yet the actual start of Mendeleev's work on the periodic table was not stimulated by pure scientific interests alone. Gordin argues convincingly that Mendeleev's teaching and pedagogical goals played important roles as well. In early 1869, when Mendeleev published his first attempt at a periodic system of elements, he was not concerned with establishing a new basic law of chemistry but with writing an introductory textbook for chemistry students at the University of St. Petersburg. The



Karlsruhe Congress in 1860, at which chemists from all over Europe reached agreement on the calculation of atomic weights, provided important insights for Mendeleev's approach to a natural classification of the chemical elements. Equally important for his approach were earlier attempts by chemists such as Jean Dumas and Johann Döbereiner who used atomic weights for the natural classification of elements. The periodic law, the proposition that the physical and chemical properties of chemical elements are periodically dependent on their atomic weight, was first established in November 1870 by Mendeleev as an originally unforeseen result of two years of intensive work that was both scientific and pedagogical.

In its final version, Mendeleev's periodic table predicted three new elements, designated "ekaboron" (scandium), "ekaaluminum" (gallium), and "ekasilicon" (germanium). But before these predictions were partially confirmed by the discovery of gallium in 1875, Mendeleev began work on new ambitious research at the border between chemistry and physics—studying gas laws, the celestial ether, and meteorological issues. Although that early form of "large-scale, organized scientific research" in Russia led to the determination of deviations in gas behavior from Robert Boyle's, Edmé Mariotte's, and Joseph Gay-Lussac's laws, it failed at its most ambitious goal—the experimental identification of celestial ether.

Under the successors of Alexander II, Mendeleev rose through the imperial hierarchy to become a major consultant. Gordin carefully follows Mendeleev's many political and scientific engagements from the 1880s until his death in 1907. He proposed educational reforms and participated in a mission to Siberia (his childhood home) to survey iron production and forests.

Gordin also covers the scientist's protectionist economic thought, his political theory, his participation in a balloon ascent for scientific observation in 1887, and the substantial revisions of his chemical textbook, *Principles of Chemistry*, in 1889. Gordin's book concludes with scientific and political events that would put Mendeleev's achievements into question: the discoveries of the noble gases, radioactivity, and the electron, as well as Russia's political revolution in 1905.

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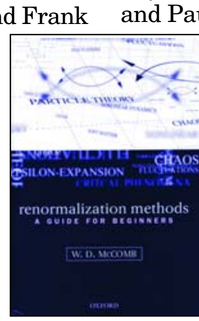
Renormalization Methods: A Guide for Beginners

W. D. McComb
Oxford U. Press, New York, 2004. $89.50 (330 pp.).
ISBN 0-19-850694-5

Renormalization originated in quantum field theory as a method of removing UV divergences in perturbation expansions. The subsequent development in the 1960s of the renormalization group introduced the novel concept of running couplings, which depend on the energy scale at which they are measured, and led to such groundbreaking discoveries as asymptotic freedom in quantum chromodynamics, for which David Gross, David Politzer, and Frank Wilczek received the Nobel Prize in Physics last year. Yet renormalization methods and the renormalization group probably have had an even more profound impact on condensed matter theory and statistical mechanics than on quantum field theory.



Aside from providing a mathematical framework from which to derive scaling laws and obtain nonclassical critical exponents near continuous phase transitions, in the past three decades, the renormalization group approach has provided a solid conceptual foundation for exploring such paradigmatic notions as universality, relevant degrees of freedom, and fixed points in parameter space. In fact, one may argue that any reduction of a complex interacting system to an effective model described by only a few variables and governed by a small set of control parameters tacitly relies on renormalization ideas. In any such model, "irrelevant" degrees of freedom are somehow integrated out to arrive at a fixed-point theory that then contains "dressed" particles and effective couplings between the remaining degrees of freedom.

W. David McComb, an expert in the field of fluid turbulence, is an avid supporter of the above overarching and almost philosophical view of renormalization. He set for himself the ambitious goal of rendering renormalization techniques and the ideas of the renormalization group accessible to advanced undergraduates and beginning graduate students in physics and neighboring sciences. I admire his courage in attempting to teach, essentially from scratch and in a mere 300 pages, technically demanding topics that encompass field-theoretic formulations based on path integrals and stochastic nonlinear hydrodynamics.

A text is certainly needed to bridge the gap between basic undergraduate course material in statistical mechanics and modern research topics. Excellent classic texts in the field, including H. Eugene Stanley's *Introduction to Phase Transitions and Critical Phenomena* (Clarendon Press, 1971) and Shang-keng Ma's *Modern Theory of Critical Phenomena* (W. A. Benjamin, 1976), miss the wide applications that the renormalization group has enjoyed more recently. Although those applications are aptly reflected in Nigel Goldenfeld's *Lectures on Phase Transitions and the Renormalization Group* (Addison-Wesley, 1992), John Cardy's *Scaling and Renormalization in Statistical Physics* (Cambridge U. Press, 1996), and Paul Chaikin and Tom Lubensky's *Principles of Condensed Matter Physics* (Cambridge U. Press, 1995), most undergraduates and beginning graduate students will find the level of those texts quite demanding. Moreover, the field theory classics such as Daniel Amit's *Field Theory, the Renormalization Group, and Critical Phenomena* (McGraw-Hill International Books, 1978) and Jean Zinn-Justin's *Quantum Field Theory and Critical Phenomena* (Clarendon Books/Oxford U. Press, 1989) most likely will be even more out of their reach.

In part 1 of *Renormalization Methods*, McComb introduces the basic ideas of renormalization. He begins on a very elementary level, which implies that he needs to explain fundamental mathematical tools such as Gaussian integrations, Green's functions, perturbation theory, and high-temperature expansions. His tour de force works quite well. He manages to cover a wide range of topics, which include anharmonic oscillators, Debye–Hückel screening, fractals, percolation, mean-field theory, dynamical systems, and diagrammatic representations and renormalization in quantum field theory. However, I find it unfortunate that Lev Landau's Fermi-liquid theory for interacting electron systems is not mentioned at all, because it so beautifully illustrates the renormalization paradigm. In addition, I noticed that quantum mechanics receives a somewhat rough treatment in chapter 1: Erwin Schrödinger's surname is misspelled, the equation named in his honor is stated incorrectly, and observables are not properly represented by operators.

Parts 2 and 3 of McComb's book describe, on a generally accessible level, the technical framework and ideas of the renormalization group for applications in statistical mechanics—from the standard topic of equilibrium critical phenomena to nonlinear stochastic dynamics. The concise treatment manages to cover the essentials appropriately, although certainly a more careful proofreading could have eliminated a few lapses. For example, I find it important to state that the renormalization procedure constitutes a semi-group and that the Ising model does display "net magnetism," namely, paramagnetism, at high temperatures. I also certainly do not understand what the author is trying to convey in chapter 7 with the misleading statement that "the Ising model is equivalent to an assumption that there are no correlations."

But more important, in the chapter on the field-theory approach, McComb fails to explain the connection between UV divergences and the infrared singularities that are physically relevant for critical phenomena. I warmly welcome the inclusion of noisy hydrodynamics and stochastic differential equations of the Langevin type. However, McComb discusses neither the Einstein relation, which in thermal equilibrium connects the white-noise correlation strength with the relaxation rate, nor the crucial