



## COMPUTATION IN MODERN PHYSICS

By Norman Choracky

W.R. Gibbs, ed., *Computation in Modern Physics*, 3rd ed., World Scientific Publications, 2006, ISBN 978-981-256-799-4, 366 pp.

My first reaction upon examining *Computation in Modern Physics* was that a better title might have been *Modern Scientific Computing with Applications to Computational Nuclear Physics*. As such, if you expect this book to treat applications of computation to modern physics beyond nuclear physics, you'll probably be disappointed. But it does represent a serious step toward integrating computation into physics education. In this review, I wish to address whether this limitation helps or hurts its intended purpose, which the editor states in the preface of this third edition as "a preparation for research in the physical sciences ... [having] an orientation toward [computation] ...." My response to this question will revolve around two issues: its content and organization as a two-part package and its suitability for use as an instructional resource.

The first of its two logical parts, "eight chapters [treating] techniques of value to many fields of science," as characterized in the third edition's preface, are topics dealing with what we could call scientific computation. This part has an unusually broad scope and includes several topics not normally found under the same tent, as it were. Thus, in addition to chapters on integration, Monte Carlo, and differential and finite element methods, it includes chapters on computer hardware and digital signal processing. Tipping a hat to modern physics, it also includes

a chapter on chaos. A separate chapter on linear algebra—material more normally injected piecemeal into such textbooks—rounds out the roster.

The second part of the book, the "final four chapters dealing with solutions to problems in quantum mechanics," deals with applications of these methods to computational problems in quantum physics and, as such, is an example of computational science. It's here that the notion of modern physics narrows to numerical solutions of Schrödinger's equation, the  $N$ -body ground state, and scattering in  $N$ -body systems. Narrower still is a chapter on methods for treating divergent series, which is arguably of importance mainly to nuclear physicists and which logic dictates belongs to the first part of the book.

This book's major strengths are its content and organization. It collects diverse but related topics under one cover—for example, in part one, I was struck to see machine architecture in the same text as signal processing. The former is important for efficient parallel programming and the latter for any experimental science. I agree with the author's assertion that understanding both of these is essential to building a solid foundation as a modern computational scientist in any field. Most computational scientists have to deal with hardware and programming choices—hence, the need to understand how computer architecture relates to its performance efficiency

for particular computational tasks. Similarly, most computational scientists have to deal with experimental data—hence, the need to understand how sampling and noise affect the information content of measurement values. The inclusion of computational physics applications—part two—in the same book as scientific computing techniques—part one—has an advantage of consistency in terminology and notation. It also has the advantage of completeness in that all the techniques necessary to treat the selected applications are included.

However, the content and organization also have a glaring limitation if this is to serve as a textbook for preparing a cadre of computationally oriented research scientists, not just physicists. Part one of this book serves this wider purpose, whereas part two is only suitable for physicists whose main concern is quantum physics. My caveat: the treatment of content, especially in part one, is so condensed it suggests a reference manual rather than a textbook. A possible resolution to these problems of scope and detail is found on the back cover in an (unsigned) assertion that this book is "suitable for two courses in computational physics. The first ... at the advanced introductory level ... for seniors or first-year graduate students." In my judgment, part one would best benefit undergraduate students of all sciences at a pace and with such supplementary material as

# Computation In Modern Physics

**Daniel F McAuley**



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