cally more advanced, if mathematically less rigorous. Thus, Lemons's *Perfect Form* may be more appropriate for the impatient science students who do not wish to concern themselves with such technicalities as existence or uniqueness but are hungry to see some worked-out examples.

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Fractal River Basins: Chance and Self-Organization

Ignacio Rodriguez-Iturbe
and Andrea Rinaldo
Cambridge U. P., New York, 1997.
547 pp. $100.00 hc
ISBN 0-521-47398-5

The relevance and usefulness of fractal geometry in the study of many different physical phenomena have increasingly been recognized since the appearance of Benoit Mandelbrot's *The Fractal Geometry of Nature* (Freeman, 1983). Fractal geometry has become a basic tool in the analysis of physical systems characterized by complex spatial structures. More recently, development of the theory of self-organized criticality by Per Bak and collaborators has provided a conceptual framework for studying systems characterized by similarly complex temporal patterns and their relation to the emergence of complex structures.

In *Fractal River Basins*, Ignacio Rodriguez-Iturbe and Andrea Rinaldo show how these two modern concepts can be harnessed to address a problem that has been of major interest to civilized societies throughout history: the nature of river basins, their physical structure and evolution. This synthesis provides a conceptual and mathematical framework within which the rich variety of river networks and their underlying order can be investigated. It may thus be viewed as the first monograph devoted to a branch of the Earth sciences that Mandelbrot suggested should be called potamology (from the Greek word for river).

The book is aimed at two scientific communities that have been largely separate in the past: hydrologists (and Earth scientists in general), who may appreciate the application of novel theoretical tools to their traditional field of research, and physicists familiar with those tools who may be intrigued by their application to an additional set of physical phenomena. The authors therefore face the considerable challenge of presenting recent research results while providing the necessary background material in hydrology, fractal geometry and self-organized criticality for the benefit of the two communities.

The result of these efforts is a dense and bulky (540-page) volume that is nevertheless a pleasure to read. The writing is clear, and the introductory material is provided in a straightforward manner. The book's organization is generally good, although there is some intentional repetition of material from chapter to chapter. Short abstracts at the beginning of each chapter clearly describe the content and focus attention on the chapter's main points. The text is packed with figures and photographs, which contribute considerably to its readability and are indispensable to any discussion of complex geometrical structures. For a first edition, there are few typographical errors in the text, and I spotted no obvious substantial errors or misstatements.

The first part of the book (chapters 1–3) is devoted mostly to providing the necessary background and introducing the theoretical tools that will be applied in subsequent chapters. The hydrology and geomorphology of river basins are reviewed in the first chapter. The relevant concepts of fractal geometry and the fractal and multifractal characteristics of river basins are presented in the next two chapters. The authors analyze the geometry of real and simulated landscapes and demonstrate the unity behind the variety of structures of natural river networks. Special emphasis is given to observational evidence of self-similarity and self-affinity in river basins. The methods used to extract this information from digital elevation models are carefully explained. This part introduces an unusually large number of technical terms and mathematical symbols, a few of which are similar enough to make some confusion possible. It would have benefited from the inclusion of a detailed list of symbols and a glossary.

The second part (chapters 4–7) is devoted to a theoretical discussion of the structure and evolution of river basins, most of which is based on recently published work by the authors and their collaborators. Introducing the principle of minimal energy expenditure in river basins, the authors construct a model of optimal channel networks and demonstrate its implications to the formation of statistically self-similar patterns. The theory of self-organized criticality for the dynamics of fractal growth is applied to the analysis of the development of fluvial landscapes. The close connection between optimal channel networks and fractal structures is discussed as a joint consequence of optimality and randomness. The main thrust of this discussion is that this model for river basin evolution produces network structures with fractal characteristics that resemble those of real basins, as obtained from high-resolution digitized satellite images. Additional elements, such as the dynamic interplay of fluvial (flow-dominated) and hill slope (diffusion-dominated) processes and the signature of climatic and geological conditions, are also nicely incorporated into this general framework.

Despite a slight tendency towards information overkill, the book is written in a clear and fluent manner and should render the topic accessible not only to members of the two research communities addressed—hydrologists and physicists—but also to graduate students intending to work in this field. It may also be useful as a source of introductory material and examples for a rather specialized course on complex systems. Physicists working on such phenomena, or wishing to enter the field, will find this book interesting and useful.

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Computational Physics: Problem Solving with Computers

Rubin H. Landau
and Manuel J. Páez Mejía
Wiley, New York, 1997. 520 pp.
$49.95 hc ISBN 0-471-11590-8
Includes diskette

Come, let us parse together and consider that deceptively simple noun phrase "computational physics." Adjective specializing the noun, it ought to mean something like "a subfield of physics based on, or heavily utilizing, computation." Indeed, at the graduate and professional levels, this is exactly what it does mean. It is a lively field of science, whose practitioners are typically the high priests of large, sophisticated numerical codes for use in hydrodynamics, plasma dynamics, gravitational N-body, lattice quantum chromodynamics and so forth. Professional computational physicists might engage in a nitty-gritty discussion on some fine point of parallel hardware memory caching or a heated debate on high-performance FORTRAN versus message passing interface.

In undergraduate teaching, however, computational physics has come to mean something different. Physicists are by nature problem solvers, and we have never been shy about using any available tool—paper and pencil, slide rule, Large Hadron Collider and, yes, the computer. Increasingly since 1990 or so, many physics departments have devised courses whose content is really something like "general, exploratory, quantitative problem solving." Computers figure prominently in these courses, since the computer is an exploratory tool without peer. But the best of these courses feature equally vital doses of analytic methods, order-of-magnitude estimation (reducing a problem to dimensionless form is often the first step in good computation), statistics (often connected to Monte Carlo methods) and just plain logical thinking.

Do these courses teach something valuable? Absolutely! Arguably, they teach precisely what physics departments have to offer as their best defense against new charges of irrelevancy. If we have something to teach biologists as they enter "their" 21st century (as the 20th century was