

with the advent of silicon metal-oxide-semiconductor (MOS) bulk transistors, silicon-on-insulator MOS transistors, gallium arsenide field-effect transistors (FETs), silicon and gallium arsenide MOSFETs, and silicon germanium bipolar transistors. A new class of devices rich in quantum phenomena, typified by the resonant tunneling diode, has the potential for high-speed and wide-bandwidth electronic devices. That those advances extend to optical and optoelectronic devices as well is covered in chapter 6, where the authors emphasize optoelectronics and lasers. They show why quantum well (QW) and strained-layer QW lasers have come to be preferred over the more conventional double-heterostructure lasers; indium phosphide/indium gallium arsenide avalanche photodiodes and QW infrared photodiodes are also discussed.

Chapter 7 provides an example of the sometimes relative nature of adjectival references: The advent of high-temperature superconductivity has resulted in descriptions of "high-temperature" operation of devices at 77 K. In this chapter, the authors discuss microwave filters, antennas, and oscillators as examples of substantial advances made possible by the high-temperature superconductors (HTS). When an HTS filter is integrated with a semiconductor low-noise, high-electron-mobility transistor amplifier, a "hybrid" front-end receiver is born. This combination of superconductor, semiconductor, and other cryogenic component technologies has resulted in a new class of high-performance communications receivers.

Even though I am an enthusiast for the book, I did find some negatives, beginning with the daunting price. The most glaring is chapter 8, titled Cryocooling and Thermal Management. It is not nearly complete enough on a subject that is well covered by several recent books and monographs. The situation is not helped by this—and only this—chapter's paucity of references (eight of them, compared, for example, with 281 in chapter 2). Further, the authors apparently overlooked the *Review of Scientific Instruments* as a rich source of papers in the field of cryogenic cooling, refrigerators, cryostats, and temperature stabilization and measurement. And the editing could have been better: He<sub>2</sub> is used as a symbol for helium (He); °K is used rather than K; 10 KG (for 10 kG); and milliKelvin (instead of millikelvin).

I do not want this review to end on a negative note, perhaps obscuring

my quite positive response. It is not just that *Low Temperature Electronics* is the only game in town; it assuredly is much more than that. It is a book for which the members of the cryoelectronics community have long been waiting. I believe that they will not be disappointed.

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## Wavelets: Tools for Science and Technology

▶ Stéphane Jaffard, Yves Meyer, and Robert D. Ryan  
*Society for Industrial and Applied Mathematics, Philadelphia, 2001.*  
\$62.00 (256 pp.).  
ISBN 0-89871-448-6

## A First Course in Wavelets with Fourier Analysis

▶ Albert Boggess and Francis J. Narcowich  
*Prentice Hall, Upper Saddle River, N.J., 2001.* \$66.67 (283 pp.).  
ISBN 0-13-022809-5

Over the past 20 years, the use of the terms "wavelets," "wavelet transform" and "wavelet analysis" has become widespread. In the physical sciences and engineering, thousands of articles have described both the use and the development of wavelet tools, and entire journals, conferences, and book series are devoted to wavelet theory and applications. Currently several applications of wavelets promise large-scale impacts, including the data compression standard JPEG-2000 and fast algorithms for rendering computer graphics (wavelet radiosity methods).

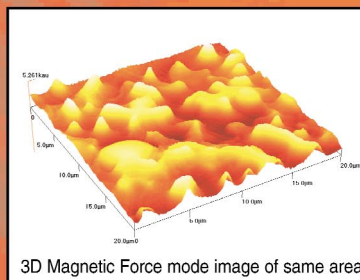
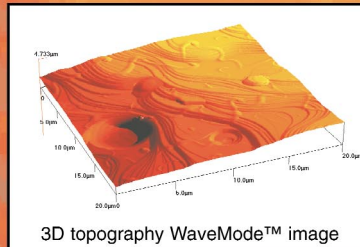
Physicists have many reasons to be attracted to a book about wavelets. These include the charming story of wavelets' "birth" as an offspring of the collaboration between geophysicist Jean Morlet and theoretical physicist Alex Grossman. There is also the relationship of wavelets to coherent states, which are of substantial interest in mathematical physics. Wavelets also play an important role in the identification and representation of transients in signals, making wavelets valuable for the proper analysis of signals in a broad range of contemporary physical experiments—measurement of the cosmic microwave background,

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studies of filaments and voids in large-scale distribution of galaxies in astronomy, and detection of gravitational waves, to name a few.

There is a broader picture, which takes longer to digest but is intellectually very satisfying. In this picture, wavelets lie at the confluence of a wide range of schools of thought about multiscale processes, capturing the essence of key ideas arising in areas as diverse as fractal analysis, the study of human vision, renormalization group analysis, and computer-aided design and manufacturing. As Yves Meyer first showed in his celebrated "Review of Two Books on Wavelets," (*Bull. Amer. Math. Soc.*, April 1993, p. 350), wavelets provide a common language for multiscale thinking in 16 different fields scattered throughout the mathematically inclined science and engineering disciplines. The story of wavelets and their relationships to similar multiscale ideas in a multitude of fields gives an intriguing picture of some interactions of mathematics, science, and technology in the late 20th century.

Stéphane Jaffard, Yves Meyer, and Robert D. Ryan take this "big picture" viewpoint in *Wavelets* and tell the story admirably, with flair and charm. While the spirit animating the discussion is clearly mathematical, the book will surprise readers who expect mathematics books to be dry and abstract. The book's approach has much in common with intellectual histories familiar to physicists; it constructs a thread linking ideas of key scientists in various eras, describes their ideas, and shows how these ideas have come together to create a coherent modern multiscale viewpoint and set of tools. This "key-scientist" approach mentions the work of many well-known mathematical scientists, including J. E. Littlewood, Alberto Calderón, Dennis Gabor, and Eugene Wigner, and it suggests linkages to the work of key scientists who were active more recently—David Marr's work in human vision, for example. Such suggested linkages arise from a scientific vision that perceives vital links between applied mathematics and science and technology. These links run not through the traditional avenue of analysis of differential equations, but rather through applied mathematicians' roles in devising ways to represent, transform, and process information rapidly as digital data.

The first seven chapters of the book set up a frame of reference: What are wavelets? Where did they come from?

What are they related to? These chapters establish background terminology in signals and transforms, describe historical trends in mathematics leading up to the development of modern wavelet transforms, and discuss parallel developments in image and speech coding and contrasting developments in time-frequency representations. Later chapters link wavelets to the study of vision, to the study of turbulence, to delicate mathematical analysis of some classic nondifferentiable functions, to data compression and noise removal, and to astronomical image processing. Each topic is treated briefly but engagingly, providing just enough mathematical content to make clear where further study can be directed and to point to interesting developments that are very recent or still in progress.

While an intellectually exciting story has its place, students inevitably need to learn details in a systematic way. Albert Boggess and Francis J. Narcowich, in their *A First Course in Wavelets with Fourier Analysis*, provide an undergraduate course in which Fourier analysis and wavelet analysis are developed simply, without such advanced mathematical tools as measure theory. While the book gives only a sketch of some applications of wavelets, it provides a thorough foundation that culminates in the discussion of Daubechies wavelets and their construction. The text also uses MATLAB® scripts to illustrate the computations underlying basic wavelet analysis. This text breaks with the traditional undergraduate introduction to Fourier analysis, which is typically presented primarily as a tool for understanding differential equations. The book's approach suggests that understanding the structure of a key information-processing tool—the wavelet transform—can be an important component of a college education. Such nuts-and-bolts understanding should be supplemented by an attempt to convey the spirit and significance of wavelet applications. The instructor might, for example, want to master Jaffard, Meyer, and Ryan, supplementing textbook instruction with remarks and examples inspired by their visionary book.

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## Theoretical Astrophysics

T. Padmanabhan

### Volume I: Astrophysical Processes

Cambridge U. Press, New York, 2000. \$120.00, \$44.95 paper (622 pp.). ISBN 0-521-56240-6, ISBN 0-521-56632-0 paper

### Volume II: Stars and Stellar Systems

Cambridge U. Press, New York, 2001. \$120.00, \$44.95 paper (575 pp.). ISBN 0-521-56241-4, ISBN 0-521-56631-2 paper

Theoretical astrophysics is a curious discipline, more like a classification than a unified field of study. A "theoretical astrophysicist" might study the dynamics of planetary rings, or the microphysics of interstellar dust, or the formation of stars, or the evolution of the universe. Although many theorists confine their attention to a single corner of the cosmos, some have worked on phenomena spanning incredible ranges of physical conditions. No matter what he or she studies, no theoretical astrophysicist can be absolutely certain what specific piece of fundamental physics might be needed to explain the problem at hand, so a formidable arsenal of weapons and the courage to delve into unfamiliar territory are essential to success. For most students entering this field, graduate study invariably includes numerous physics courses to provide the basics, as well as astronomy courses designed to introduce the phenomenology. For students and researchers alike, frequent trips to previously unexplored sections of the physics library fill in the blanks left by courses that could not quite pinpoint the right physics needed to ply the trade.

Thanu Padmanabhan, an eminent astrophysics theorist at the Inter-University Centre for Astronomy and Astrophysics in Pune, India, attempts to bring all of theoretical astrophysics under a single tent in a projected three-book series titled *Theoretical Astrophysics*. The first two volumes, *Astrophysical Processes* and *Stars and Stellar Systems*, have appeared. Volume 3—*Galaxies and Cosmology*—is due later this year. His goal for the series is to write "something analogous to the famous Landau–Lifshitz course in theoretical physics, but focused to the subject of theoretical astrophysics at a fairly advanced level."

Volume I deals with the fundamentals, and is a dizzying romp through subfields of physics ranging