network of the worm *Caenorhabditis elegans*, the power grid of the western US, and the collaboration graph of film actors—can all be described in this way.

This is, roughly, the content of Watt's book. The ideas are applied to many phenomena, and the (rather simple) mathematics is presented in every detail. A rather unrelated and quite uninspired chapter on cellular automata and coevolutionary games is tagged on.

Watts's interest in networks came from a study of synchronization of biological oscillators—crickets, to be precise. Each cricket listens to the chirps of other crickets and adjusts its chirp in response, and the whole population winds up oscillating as one. But who is listening to whom? How are the crickets linked? Clearly, long-distance shortcuts increase the tendency towards synchronization. Also, random shortcuts facilitate signal propagation in communication networks as well as computational power in computer networks. In our modern internet world, everybody is directly connected with everybody, so our "internet number" is unity—the extreme small-world case.

Watts addresses an extremely interesting subject, but in a weak and superficial way. The formation and the dynamics of networks are at the core of the entire field of complexity. Scientists like biological physicist Stuart Kauffman have spent lifetimes trying to understand the structure of genetic regulatory networks, and the entire field of ecology deals with the dynamics of networks of interacting species. Why does a given network have a given structure? What is the function of the network related to its structure—is something being optimized? The optimizing of networks is another subject of great interest, and has been applied by Andrea Rinaldo and coworkers at the University of Padova, Italy, to such problems as the formation of river networks. How about the network of economics agents, and of neurons in the brain? Why does the network of *C. elegans* have the geometry that it has? And there is much more.

The connectivity in all of these systems is certainly more involved than Watts's simple *ad hoc* structure; presumably there is often a whole range of interactions covering everything from the local neighborhood to faraway strangers. A visual inspection of the map of the western-states power grid depicted in the book indicates that this is indeed so. And what is more important, despite the subtitle of the book, there is nothing here about the dynamics of networks; only the geometry of static, predefined structures is discussed. Watts seems to be strangely unaware of the scope of the exciting field that he seeks to cover. The reader who gets his information on networks only from Watts will be left in the dark with respect to an extremely exciting and active field of research.

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Principles of Seismology

Agustín Udías
Cambridge U. P., New York, 1999.
475 pp. $90.00 hc ($39.95 pb)
ISBN 0-521-62434-7 hc
(0-521-62478-9 pb)

Introduction to Seismology

Peter M. Shearer
Cambridge U. P., New York, 1999.
260 pp. $74.95 hc ($29.95 pb)
ISBN 0-521-66023-8 hc
(0-521-66953-7 pb)

As I read through the new textbook, *Principles of Seismology*, by the Spanish geophysicist, Agustín Udías, I was reminded of some of the scenes at the University of Tokyo, where I started my graduate study: dark hallways, high humidity, the particular smell of the building in which the department of geophysics was housed at that time. All of these came back to me as vivid memories. This is probably because Udías's new book somehow made me recall the first seismology textbook I read in that building, K. E. Bullen's *An Introduction to the Theory of Seismology* (Cambridge U. P., 1963).

This is not to say that Udías's book is a copy of Bullen's; it is definitely not. But it is probably based on the same tradition, perhaps a European tradition. It covers a wide range of topics, such as the brief history of seismology, basic physics of wave propagation, and various topics on the generation, propagation, and recording of elastic waves in Earth. It contains everything I would want my graduate students to have as their initial core knowledge of seismology as they delve into their research. All concepts, both theoretical and observational, are concisely explained within a few pages, and descriptions are crisp and clear. Overall, the whole book is built on the accumulation of such concise, well-written short segments.

Udías's book is an intermediate-level textbook and assumes a good mathematics and physics background. Upper-level undergraduate students in physics may be able to handle it, but in general it seems most appropriate for first-year graduate students. It is easier to read than the now classic seismology textbook by Keiiti Aki and Paul G. Richards (*Quantitative Seismology*, Freeman, 1980), which I struggled through as a graduate student. And yet this book covers almost the same range of material as volume 1 of Aki and Richards; any student who can digest it will be well equipped to attack any seismological research topic. Explanations are comprehensive, in that they do not skip essential derivation processes, but they are more mathematical than physical, which is not necessarily to my personal taste. For example, Udías spends a page deriving the Eikonal equation in ray theory. In my opinion, this could have been shortened greatly by invoking a simple physical argument. On the other hand, there may be nothing wrong in requiring serious students of seismology to go through such algebraic details.

Udías's book aims at the same audience as *Modern Global Seismology* by Thorne Lay and Terry C. Wallace (Academic, 1995); the Lay and Wallace book has more real examples from current research topics and is thus superior in providing exposure to current data. But Udías presents theoretical concepts in a crisp and complete manner; his work seems superior in that regard.

Peter M. Shearer's *Introduction to Seismology*, on the other hand, is a practical, typically American textbook. Although it is not clear how much time we would need to go through Udías's book (less than some Russian novels), Shearer's book clearly aims to be the best textbook for a one-quarter course. There seems to be a relationship: Quarterly instruction consists of ten weeks; this book has 11 chapters, with the last chapter being called "Miscellanea."

The targeted level for Shearer's book is slightly lower than that for Udías's. The material in general is easier to follow, perhaps because explanations are more physical and intuitive than those Udías uses. Shearer's book is certainly limited in scope by the selection of topics appropriate to a one-quarter course, but it touches on essential aspects of seismology, starting from basic elasticity and wave propagation (ray theory and wave theory) and moves on to well-known techniques in reflection seismology and elementary introductions to source theory and earthquake prediction. There is a good selection of problems after each chapter, with some identified as computer projects. These computer assignments are excellent problems for laboratory work typically associated with a seismology course in the US.

Although Shearer's book can be used for self-study, it is in essence a textbook to be used with an instructor. As an introductory course textbook for upper-level undergraduate students (and perhaps some graduate students with no previous exposure to seismology), it may be the best textbook available now. For more advanced students, aiming to become seismologists, Udías's book provides an excellent, broad overview of seismology. I would be happy to go through it in reading courses with my own graduate students. It would be a good introduction for students who are to become well-balanced researchers.

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Radiative Transfer in the Atmosphere and Ocean

Gary E. Thomas
and Knut Stamnes
Cambridge U. P., New York, 1999.
517 pp. $85.00 hc
ISBN 0-521-40124-0

The transfer of solar and thermal radiation within a coupled atmosphere–surface system is of fundamental importance in Earth and planetary sciences. Applications include energetics and climate modeling as well as remote sensing and photochemistry. Despite its critical role, radiative transfer is often found to be a relatively frustrating field for students. This may be due, in part, to the lack of good introductory texts and the many disciplinary backgrounds of students in Earth science programs (physics, chemistry, engineering, meteorology, and the like).

The new offering by Gary Thomas and Knut Stamnes, *Radiative Transfer in the Atmosphere and Ocean*, is the culmination of the authors' teaching efforts over many years. It is a welcome addition to the small number of existing alternatives concerned with radiative transfer fundamentals and tools. The text is intended for advanced undergraduates and beginning graduate students in atmospheric and oceanic sciences, but it also provides a useful reference for the practitioner. Our review draws on our involvement in the development of a graduate course for which the book served as the main text.

A strength of the book is its early effort to emphasize the fundamental physics underlying radiative interactions and to provide useful insight. It uses the classical Lorentz theory for describing molecular scattering and line shapes, and it describes nicely quantum mechanical considerations pertinent to molecular absorption. These discussions are not intended to be for detailed descriptions (as, for instance, is *Atmospheric Radiation: Theoretical Basis* by Richard M. Goody and Yuk L. Yung, Oxford, 1989). The same can be said of the brief introduction to Mie (spherical particle) scattering; other texts can be consulted for the full mathematical derivation. Polarization is not discussed.

The intuitive fashion in which the various incarnations of the radiative transfer equation and its solutions are developed is another strength. Chapter 7 is a thorough treatment of the two-stream approximation and examines a large number of special cases. Chapter 8, on "accurate" numerical techniques, emphasizes the discrete ordinate method and follows nicely from the two-stream discussion. One may argue, however, that the 40-page presentation is at the expense of other methods that are arguably more intuitive and also widely used. These include, for instance adding/doubling, successive orders of scattering, and Monte Carlo methods. Although both chapters are rich in numerical detail, the unsophisticated reader would benefit from additional instructive examples and figures. For instance, a summary of radiance and flux dependencies on optical thickness, particle absorption, and solar geometry would have been valuable.

We appreciated the clear review of climate issues and the summary of radiative transfer concepts for climate applications presented in the last two chapters. Two details that drew our attention in these chapters were the summary plots of atmospheric absorption spectra in chapter 11, usually presented much earlier in books of this type, and the exclusive use of the term "greenhouse effect" in chapter 12 for a mathematical quantity.

A major concern is the book's seem-