

undertaking is a bold one, since each example presented requires significant explanation of its own physics, even before the issue of scale invariance is discussed. The reader will be surprised by the level of breadth and depth attained in this book of less than 400 pages.

The book begins with an introduction to scale invariance in the context of critical behaviors. Chapter 2 provides an overview of fractals and introduces self-similarity concepts. In chapter 3, the authors describe scaling relations and the renormalization group and its use in predicting critical behaviors. Subsequent chapters address scale invariance in specific physical phenomena.

In addition to the high quality of its numerous diagrams and plots and the admirable readability of its equations and fonts, *Scale Invariance* is well written and surprisingly engaging. Particularly so is chapter 4, which contains a fine presentation of anomalous diffusion. The authors also do an excellent job of including the history of the topics they present; they make wise decisions about when to include significant historical details and when to blur over them. Occasionally, though, the writing seems overwrought. For example, relatively simple points are often delivered in an unnecessarily complicated fashion, and sentences can be much longer than necessary. Perhaps the translation of the original from French to English is partly to blame.

The discussion of turbulence, its appearance in the book's title notwithstanding, is relegated to one section in the chapter on chaotic dynamics, which appears near the end of the book. Unusual as that seems, it is perhaps appropriate: Although turbulence is a problem of great importance, it is also a largely unsolved phenomenon, and the authors generally focus on topics in which greater understanding has been attained.

The diligent reader will benefit from *Scale Invariance*, but as can be expected for a book covering a broad range of topics, an exhaustive explanation of each topic is not possible. Significant overlap exists between *Scale Invariance* and various books on chaotic dynamics and universality. *Universality in Chaos* (2nd edition, Taylor & Francis, 1984), edited by Predrag Cvitanović, comes to mind. Its focus is different, but both books include such topics as fractal geometry, strange attractors, turbulence, and Lyapunov exponents.

The authors provide detail on each

topic, but not enough to adequately educate the novice or to satisfy the expert. For their type of presentation to work, it is crucial that the authors focus on the book's unifying theme of scale invariance. And, to be fair, they do return to that theme in each chapter; but at times they don't emphasize the idea strongly enough, and some of the chapters tend toward becoming merely a survey of the topic under discussion.

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Field Theory of Non-Equilibrium Systems

Alex Kamenev
Cambridge U. Press, New York, 2011.
\$80.00 (341 pp.).
ISBN 978-0-521-76082-9

Our theoretical understanding of non-equilibrium statistical mechanics—a challenging subject—has been largely restricted to such near-equilibrium

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approaches as linear response theory and the fluctuation–dissipation theorem. There is a good reason for that: The richness and variety of nonequilibrium phenomena, it seems, means that it's hard to identify universal constraints or construct generally applicable computational schemes.

One surprising exception is the so-called Keldysh technique, which is suitable for a broad range of phenomena (though there is also a large set of phenomena to which it doesn't apply). The technique

emerged from work done in the 1960s by Leonid Keldysh, Gordon Baym, Leo Kadanoff, and Julian Schwinger. It's difficult to describe in non-technical terms, but it can be viewed as an extension of Feynman's path-integral technique to nonequilibrium statistical mechanics. By necessity, the evolution operators of nonequilibrium statistical mechanics involve both forward and backward time directions. The Keldysh technique, roughly speaking, centers on expressing those evolution operators as suitable

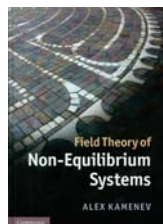
quantum field theory integrals over closed time contours. The resulting integral expressions turn out to be computationally effective.

Field Theory of Non-Equilibrium Systems, written by theoretical condensed-matter physicist Alex Kamenev, is a lively pedagogical exposition of the Keldysh technique based on functional integration. At the start, the author uses the simplest possible system—a harmonic oscillator—to provide a detailed description of the method. He shows how the technique is applied in that familiar context and builds on that framework for more complex examples. The remaining early chapters, covering such areas as classical stochastic systems and fully interacting bosonic fields, outline the general procedure.

The later chapters, which can be read more or less independently, are devoted to various carefully chosen applications, based on such classical topics as the dynamics of collisionless plasma and electron–electron interactions in disordered metals. The author appears to have given a great deal of thought to the choice of material, with the goal of presenting a few key topics in strikingly clear pedagogical terms. For example, the 20-page discussion (in chapter 10) on the quantum transport of free fermions can easily be expanded into a monograph.

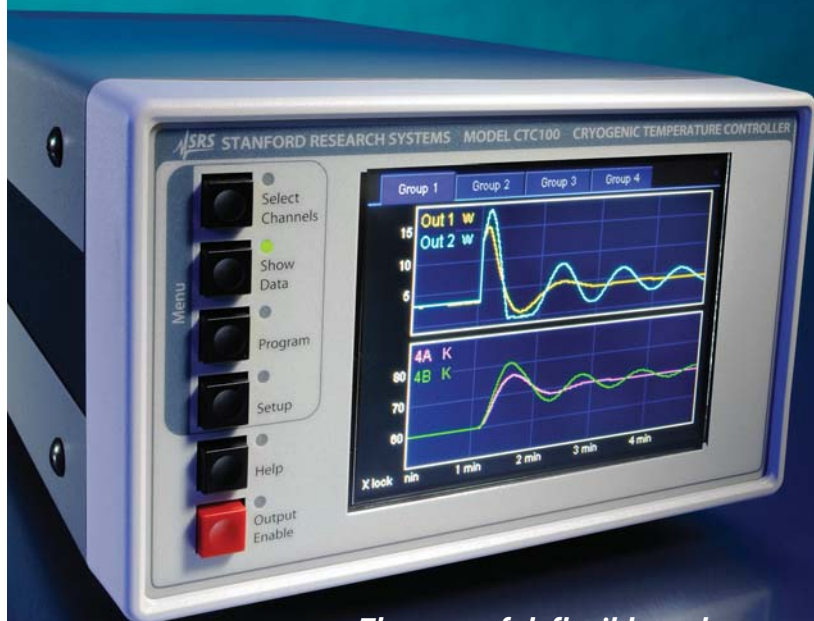
One shortcoming of the book is that experimental results are not discussed, possibly due to space limitations. Although that is understandable, readers may wish that the book had an accompanying volume with carefully chosen experimental results presented in similar pedagogical terms. Also, the author references the original papers from the vast literature on the Keldysh technique, but he provides almost no discussion of the developments in a historical context. That, too, is understandable; but given the author's expertise and wisdom in choosing topics, an appendix that discussed the historical context of each chapter and that mentioned related developments not discussed in the book would have been invaluable to the intended readership.

The book is not, and was not intended as, an encyclopedic exposition of the Keldysh technique. It is meant for advanced graduate students and professionals who have not had prior exposure to the technique but would like to learn it. Experts in the field may also enjoy the diversity of the subjects covered and the clarity with which they are presented. Thanks to those features, *Field Theory of Non-Equilibrium Systems*



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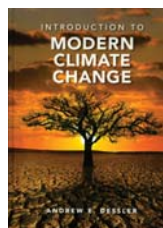
is a welcome introduction to the field and could well become a classic.

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Introduction to Modern Climate Change

Andrew E. Dessler
Cambridge U. Press, New York, 2012.
\$110.00, \$50.00 paper (238 pp.).
ISBN 978-1-107-00189-3,
ISBN 978-0-521-17315-5 paper

Scientific observations and analysis provide strong evidence for climate change, one of the most important issues facing humanity in the 21st century. All citizens need to understand the importance of the changes occurring in



Earth's climate and how further changes are likely to affect them, their children, and their grandchildren. However, Earth's climate system is extremely complex, and climate scientists often

find it difficult to convey their own level of understanding or to discuss what can be done about climate change.

Nominally aimed at undergraduate nonscience majors, *Introduction to Modern Climate Change* by Andrew Dessler is full of information about the basic science of the climate system, the changes occurring globally, the potential impacts on humans and ecosystems, and the economic and policy considerations for responding to climate change. The book reads extremely well: It uses stories, analogues, and examples to draw the reader into the story of the science of our changing planet. Despite the complexity of the actual science, Dessler presents the material in a clear manner and does it without drawing on mathematics any more difficult than simple algebra. He also manages to stick to the science and avoid advocacy, and in doing so, he addresses several frequently asked scientific questions and corrects some misinformation found in blogs and in other media.

The first seven chapters discuss the basic physics of Earth's climate system, the evidence for changes occurring to our climate, and the basis for attribution to human activities. The next few chapters discuss the various factors that go into the development of representative future scenarios for emissions of

heat-trapping gases and particles from human activities, including affluence, population, and technological development. The resulting projections for changes in climate during this century, along with the basis for the projections, are evaluated and then used in discussing potential impacts on humans and the environment. In the last four chapters, Dessler draws on his experience as a senior policy analyst in the Clinton administration. He discusses the complexities affecting policy decisions, the need for economic analysis, and the options for responding to climate change, namely adaptation and mitigation, including geoengineering.

The book has several aspects I don't like. Some formatting and layout choices were likely based on keeping costs and book length in check. For example, most of the graphics use grayscale, with only a few pages in the center providing color plates. In addition, in many places additional graphics could have helped tell the story more clearly. Of even more concern to me is that the book focuses largely on temperature change. Only one page of text discusses changes in precipitation. Changes associated with severe weather events such as heat waves, cold waves, flooding, and droughts are likely to be extremely damaging to human society; the discussion of them is inadequate. Observations show that over the past 50 years, more and larger precipitation events are occurring nationally and globally, but that is also not discussed.

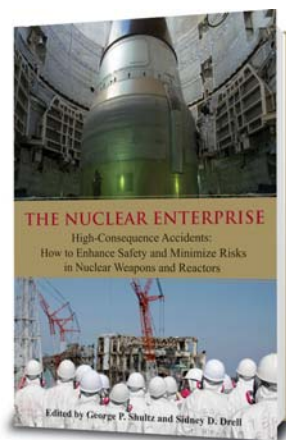
Other books, with admirable features, could be used for a course for nonscience majors. Two that come to mind are *The Rough Guide to Climate Change* (3rd edition, Rough Guides, 2011) by Robert Henson and *Dire Predictions: Understanding Global Warming* (DK Publishing, 2008) by Lee Kump and Michael Mann. *The Rough Guide to Climate Change* is much more comprehensive than Dessler's book in discussing the issues, and *Dire Predictions* uses many outstanding graphics to present the story of climate change.

However, *Introduction to Modern Climate Change* does a better job than either of those books at getting to the heart of the science and at analyzing the philosophies leading to possible policy options. I recommend this book for anyone interested in learning more about climate change and the challenges it presents to humanity.

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