Principles of Planetary Climate avoids advanced mathematical techniques. To make it possible for the student to work realistically messy problems, along with the book, Pierrehumbert has prepared software and data files for numerical experiments. Most of the modeling is one-dimensional and therefore amenable to numerical investigation with simple programs. The problems are excellent. The presentation of radiation balance and the greenhouse effect in this book is the best I have seen. Obtaining gas absorption spectra—usually the show-stopper for teaching radiative balance and greenhouse effects—is aided by weblinks to the high-resolution transmission molecular absorption database (HITRAN) archived by the Harvard–Smithsonian Center for Astrophysics. The included software also contains strategies for performing calculations with HITRAN. The range of behaviors that vertical heating profiles can display is exhaustively, authoritatively, and yet playfully explored, with each case presented as a puzzle to be enjoyed.

Pierrehumbert is an expert in the field of fluid dynamics. Knowing that, I looked forward to the book's last chapter, "A peek at dynamics." Sadly, the title is accurate. The author seems to have run out of steam just when he was positioned to illuminate the most difficult subject in climate studies. A treatment of dynamics with the depth and thoroughness of the radiation chapters would have been a service to the community. Perhaps we will see it in future editions.

Principles of Planetary Climate presents atmospheric science as it is derived from first principles and thus lays the groundwork needed to move on to exoplanets, where it would be highly risky to assume that properties can be understood from solar-system experiences. Indeed, I was fortunate enough in 1965 to take a course in climate science from Jule Charney, a giant in the field of atmospheric dynamics, and I recall his warning that "nothing is predicted in this field. Phenomena are observed, then rationalized." One striking example from our own solar system is Venus; even the gross character of the general circulation was unpredicted and unknown until observations surprised astronomers in the 1960s.

All three books raise a question about the exoplanet excitement. Climate study of distant planets will require details of circulation and atmospheric structure far beyond present observational capabilities. Will Charney's warning apply, or are we now better at predicting phenomena? Either way, these texts on planetary climate and atmospheres provide a broad, exciting, and useful perspective on the exoplanet revolution in astronomy.

The Quantum Story
A History in 40 Moments

Jim Baggott
Oxford U. Press, New York, 2011.
$29.95 (469 pp.).
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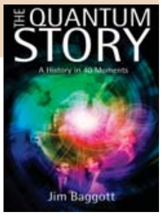

Both history and popularization of science are essential for public understanding, but the relationship between them is akin to Niels Bohr's complementarity. Books that attempt to present scientific ideas in a straightforward manner often simplify historical issues to the point of distortion. On the other hand, attempts at maximum historical accuracy unnecessarily complicate the task of popularization since original and now-accepted interpretations rarely coincide.

In *The Quantum Story: A History in 40 Moments*, Jim Baggott achieves a balanced synthesis between both approaches while avoiding the above extremes. His primary goal is to explain, using historical and biographical vignettes, the contemporary state of quantum theory to nonspecialists who understand basic physics. Baggott has a talent for elucidating scientific ideas, including some of the latest sophisticated developments. Quantum physicists and professional historians of physics will also find much novel in his presentation, though they might disagree with him in places.

The book encompasses two rather different quantum stories under one cover. The first, more expected narrative presents the key steps on the road to quantum mechanics—from the 1900 Planck formula to the 1926 Schrödinger equation, interpretations leading to the uncertainty relation and complementarity, and the series of debates between Albert Einstein and Bohr that culminated with the 1936 Einstein-Podolsky-Rosen paradox. With lesser attention to the middle decades of the century, *The Quantum Story* proceeds to more recent conceptual developments involving Bell's inequalities, entanglement, and decoherence.

In comparison with Baggott's earlier book, *The Meaning of Quantum Theory: A Guide for Students of Chemistry and Physics* (Oxford Science, 1992), this edition adds some of the latest experiments but also shifts the tone of conclusion. The 1992 work praised quantum dissidents whose doubts about the Copenhagen interpretation had opened new theoretical and experimental questions and made several competing interpretations possible. Today, the author appears less interested in the alternatives: David Bohm's hidden-variables approach is still explained at length, but the many-worlds interpretation is discussed only briefly, and the more realistic ensemble interpretation is not mentioned at all. Baggott seems more satisfied with the simple lesson that quantum mechanics is "spooky" and involves some "weird" action at a distance; he does not mean to criticize but rather expects such words to please today's general audiences.

The book's second story goes beyond the continuing struggle to understand quantum mechanics's murky foundations and discusses its subsequent applications and developments. Here the author faces a daunting task because quantum physics has branched out into a number of fields, each with its own set of basic concepts. Anyone trying to represent the richness of this diversity must make difficult choices. Baggott is very good at explaining the topics he selects, but he seems completely unreflective about the rather narrow road chosen. He focuses on quantum field theory and the standard model of particle physics, while practically ignoring condensed matter, nuclear physics, astrophysics, quantum optics, and complex systems. Selected episodes center almost exclusively in the Anglo American world, with little attention given to the international character of quantum physics and important developments that took place in Calcutta, Moscow, Osaka, Rome, São Paulo, and Trieste.

Even when dealing with quantum fields, Baggott skips the theory's crucial founding stage and proceeds directly to the second act, which begins with renormalization and ends with W and Z bosons and superstrings. Some of the most fundamental quantum concepts thus remain unexplained, including the very idea of a quantized field, advocated by Pascual Jordan; antiparticles, predicted by Paul Dirac; the loss of individuality, uncovered by Satyendra Nath Bose and Paul Ehrenfest; quasiparticles (for example, holes, phonons, and excitons), introduced by Yakov Frenkel and Lev Landau; and the concepts of weak and strong interactions, developed by Enrico Fermi and Hideki Yukawa, respectively.

The second narrative's selected focus gives the book an unintended new meaning, since the reader cannot help but notice a striking contrast between its two stories. One reads like a suspense drama, with physicists absorbed in critical dialogs and challenging each other's fundamental beliefs. The other reflects the style of banquet speeches celebrating Nobel Prizes; disagreeing voices are no longer heard and debating the foundations is often dismissed as "metaphysics" and discouraged in favor of constant pushing forward.

The Quantum Story characterizes the current situation in quantum field theory as a crisis caused by theoretical speculations running ahead of experimentalists' limited financial resources. But it may also be that theorists have gone far too long without looking back at and critically re-examining their basic assumptions. After all, a hundred years ago authoritative physicists were also expecting sophisticated experiments to prove their latest "theory of everything" and a grand unification under electromagnetism. Instead, the developments took an unexpected turn after an unknown patent clerk in Bern, Switzerland, published a paper that contained some thought experiments and a "mere philosophical" analysis of the concept of simultaneity.

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The Second Law of Economics
Energy, Entropy, and the Origins of Wealth

Reiner Kümmel
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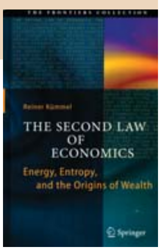

It is no easy task to write a book that is targeted at a broad audience and merges essential concepts of thermodynamics, statistical physics, and economics. However, theoretical physicist Reiner Kümmel succeeds in doing just that with *The Second Law of Economics: Energy, Entropy, and the Origins of Wealth*. The book discusses the impact of two fundamental laws of nature—energy conservation and entropy production—on the creation and growth of wealth. For more than 30 years, Kümmel has been at the forefront of the study of economic thermodynamics, which considers the relationship of the natural sciences to economics—thermodynamics and economics are bridged by the constraints that thermodynamic laws place on natural-resources availability and economics-based environmental preservation.

In the first chapter, the author presents Abel, an observer "beyond space and time." Like the three spirits in Charles Dickens's *A Christmas Carol*, Abel guides the reader through fundamental historical scientific and technological events, beginning with the Big Bang and the evolution of life on Earth and moving to the Industrial Revolution and the rise of the semiconductor industry. He describes the development of agricultural processes, the rise and fall of civilizations, and modern-day challenges of mitigating air pollution and replacing fossil fuels with renewable energy. The chapter is short, and some discussions, such as the one about