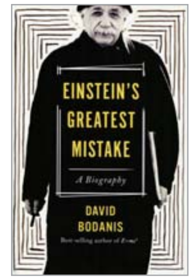
Einstein's Greatest Mistake

A Biography

David Bodanis

Houghton Mifflin Harcourt, 2016. $27.00 (304 pp.). ISBN 978-0-544-80856-0



David Bodanis is a popular-science writer and the author of a clever and successful "biography" of Albert Einstein's famous equation, $E = mc^2$. In an interview about the book, Bodanis said that he elected to write about the equation instead of offering "yet another account of all of relativity, let alone another biography of Einstein—those are interesting topics, but have been done to death."

Well, time has passed, and apparently Bodanis has warmed up to the idea of attempting yet another account of Einstein's life and scientific achievements. Einstein's work is so historically significant, his era so turbulent, and his personality so magnetic that his biography has become the *Hamlet* of science writing: Few can resist the urge to take it on and give it their own interpretation. But for any new effort to gain traction, it has to provide an immediate and plausible answer to the question, What is new here? The answer in the case of *Einstein's Greatest Mistake: A Biography* is disappointing. The book has little originality, and its poor structure results in a misrepresentation of the scientific history.

As with his earlier book on $E = mc^2$, Bodanis is clearly aiming this one at true lay readers and not at scientifically trained people or even science hobbyists. He omits huge swaths of Einstein's scientific work and the related biographical material, bringing the book's narrative in at a slim 235 pages. To put that number in context, reasonably comprehensive biographies of Einstein, which discuss both his science and life, are a heavy lift. Walter Isaacson's excellent book, *Einstein: His Life and Universe* (Simon & Schuster, 2007), came in at a concise 551 pages, and the superb biography by Albrecht Fölsing, *Albert Einstein* (Viking, 1997), fills 742 pages.

The ostensible hook for Bodanis's book is in the title: *Einstein's Greatest Mistake*. We are to learn about the fallibility of genius. However, that is hardly a new approach. Just in the past few years we have had *Brilliant Blunders: From Darwin to Einstein* by Mario Livio (Simon & Schuster, 2013) and *Einstein's Mistakes: The Human Failings of Genius* by Hans Ohanian (W. W. Norton, 2008). The novelty of the idea that Einstein could have been wrong about something in science has worn off. And it turns out (spoiler alert) that the "greatest mistake" of which Bodanis writes was Einstein's rejection of quantum mechanics, which is not going to be news to many readers of Physics Today.

A lack of originality still leaves room for a book to succeed if well executed. The lay reader whom Bodanis is addressing may well know about Einstein only through the equation $E = mc^2$ and terms like relativity and curved space. They may not appreciate the enormous significance of Einstein's refusal to accept the new atomic theory long after its experimental validity and utility were confirmed. However, Bodanis does not seem to want to write a book with that emphasis. In fact, the first 175 pages of *Einstein's Greatest Mistake* barely mention anything to do with atomic theory. Instead, the first few chapters are largely a reprise of his previous book, and Bodanis leaves the reader with the impression that the "miracle year" (1905) was mainly focused on mass–energy equivalence rather than special relativity, Brownian motion, or the photoelectric effect.

By chapter five we are on to the quest for general relativity. That theory and its cosmological consequences, including Einstein's introduction of the cosmological constant, will take up more than half the book. The biographical narrative is told as though relativity theory was Einstein's only focus between 1905 and 1916. In fact, Einstein's main obsession from 1905 to 1911 was quantum theory, as exemplified by his 1908 statement, "This quantum question is so extraordinarily important and difficult that everybody should work on it."

Only 40 pages near the end of the book are reserved for trying to get across the basic ideas of the quantum revolution, Einstein's role therein, and his eventual irrevocable rejection of quantum mechanics. The uneven distribution of authorial effort rules out any hope of communicating the science underlying Einstein's position on quantum mechanics. *Einstein's Greatest Mistake* devotes no time to explaining Einstein's seminal work on light quanta and the quantum theory of specific heat. According to Walther Nernst in 1910, Einstein's quantum hypothesis was "probably the strangest thing ever thought up. If correct, it opens entirely new roads … for molecular theories."

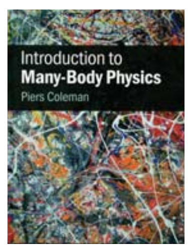
Bodanis seems to have gone a step beyond the famous warning that one's readership is divided in half for each equation in the text. He has an aversion to terminology that *sounds* mathematical. Even the term "acceleration" appears to be a bit technical in his view. In presenting the famous thought experiment in which people in an elevator cannot distinguish undergoing uniform acceleration at g in empty space from being on Earth's surface weighed down by gravity, Bodanis describes the riders as having a "tug pulling them along … of the right intensity." That kind of vague language doesn't generate better understanding.

There are also outright problems with some of the book's physics. Here is one example likely to upset physicists: "If mass were simply magnified by the factor of the speed of light … it would produce a tremendous amount of energy." No, it wouldn't; it would produce some amount of momentum (the units of mc), which will be "big" or "small" depending on what is a relevant momentum scale for comparison. A valid point can be made here about mass–energy conversion, but it has to be stated more carefully.

The purely biographical part of the book is pleasant in the main, but nothing stands out. Although *Einstein's Greatest Mistake* was never intended to be an Einstein biography for physicists or science geeks, neither can I recommend it to a humanist friend who wants to get a sense of the major concepts in Einstein's work.

A. Douglas Stone
Yale University
New Haven, Connecticut

Introduction to Many-Body Physics



Piers Coleman

Cambridge U. Press, 2015. $84.99 (810 pp.). ISBN 978-0-521-86488-6

The goal of quantum many-body physics is to understand the emergent properties—probed by thermodynamic, spectroscopic, and linear response functions—of a system of many interacting particles. As early as the 1950s, the methods of quantum field theory were applied to quantum fluids of fermions and bosons. Those efforts culminated in 1957 in the Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity. In 1963 Alexei Abrikosov, Lev Gor'kov, and Igor Dzyaloshinskii wrote their classic book *Methods of Quantum Field Theory in Statistical Physics* (Prentice-Hall) on the use of Feynman diagrams to attack many-body problems at finite temperature. Terse but full of insights, the book had an enormous impact and is still used by practitioners.

However, the field has advanced tremendously since the 1960s. Subsequent decades saw great progress in addressing new many-body systems—such as those exhibiting the Kondo effect, disordered systems, superfluid helium-3, and unconventional superconductors—and the development of new tools, such as functional integrals and the renormalization group. Students and instructors of quantum many-body physics need an updated, modern textbook that covers those developments. *Introduction to Many-Body Physics*, a new book by Piers Coleman, successfully fills the need. Coleman, an eminent condensed-matter theorist at Rutgers University, covers his subject with pedagogical flair and attention to detail.

The book, which assumes the reader has no more than a knowledge of first-year graduate quantum mechanics, has two central aims. The first is to introduce a variety of techniques in many-body physics. The second is to illustrate the power of these techniques using detailed examples from condensed-matter physics.

Coleman seems keenly aware of a common problem with many-body textbooks: Readers, especially newcomers to the field, tend to get overwhelmed by the mathematics and lose sight of important physical ideas. To ensure that does not happen, he discusses the phenomenology and experimental background for each topic and even includes a bit of history. He also includes plots of experimental data that serve to motivate the theory or illustrate tests of theoretical predictions. Coleman makes excellent use of color illustrations to illuminate qualitative ideas and, at regular intervals, emphasizes important results by highlighting them in boxes or tables. Experienced researchers might find some of the derivations overly lengthy, but beginning graduate students will benefit greatly from the level of detail. Students will also find the many solved examples and exercise problems useful.

Introduction to Many-Body Physics is more than 800 pages long and thus is able to provide wide-ranging coverage of topics central to the field. The book skillfully matches theoretical concepts with experimental probes. For example, the chapter on linear response successfully emphasizes the connection between theoretical correlation functions and observable consequences like photoemission, neutron scattering, and optical conductivity.

Two chapters in the middle of the book develop key phenomenological ideas. One of them focuses on Ginzburg–Landau theory and does a marvelous job of introducing the ideas of broken symmetry, phase rigidity, topological defects, and the Anderson–Higgs mechanism. The other carefully explains phenomenological aspects of Landau's Fermi liquid theory, but has little discussion of its microscopic formulation, which would have been of great value for students. Furthermore, the discussion of the T^2 resistivity arising from electron–electron interactions is somewhat misleading. The reader should have been warned that this mechanism by itself does not give rise to resistance, unless *umklapp* scattering or disorder degrades the momentum of electrons.

Later chapters of the book describe several topics in condensed-matter