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Eine neue Größe der Weltgeschichte: Albert Einstein, dessen Forschungen eine völlige Umwälzung unserer Naturbetrachtung bedeuten und den Erkenntnissen eines Kopernikus, Kepler und Newton gleichwertig sind.

Phot. Hugo Böck

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As his celebrity began to take off, Albert Einstein graced the cover of the 14 December 1919 edition of the *Berliner Illustrirte Zeitung* (Berlin Illustrated Times).

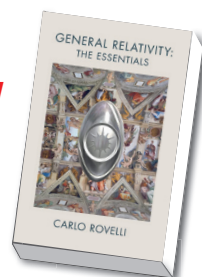
Spacetime, essentially

In a June 2012 *PHYSICS TODAY* article, Nelson Christensen and Thomas Moore divided textbooks on general relativity into three broad classes. Their first category was books with a math-first approach, which tend to focus on the math-

ematical tools of the theory before applying them to the physics of spacetime. Second was authors who take a physics-first approach, who describe the geometry of several spacetimes and explain how particles and light move through them be-

General Relativity The Essentials

Carlo Rovelli
Cambridge U. Press,
2021. \$64.99



fore demonstrating how those spacetimes are derived. Finally, they described the active-learning approach, which emphasizes intertwining mathematics with example spacetimes so that students can learn tensor calculus through example.

In his recent textbook, *General Relativity: The Essentials*, Carlo Rovelli pioneers a new approach—which I’ll call “concepts first”—that places physical motivations and reasoning front and center. Rovelli relentlessly limits the mathematical exposition and gives copious room to the conceptual and physical insights of the theory. The pithiness of the book complements that approach and gives the reader a global view of general relativity. That is a major advantage for someone who wants to learn what the theory is about and is studying to become one of its craftspeople.

Physics-first textbooks weave Albert Einstein’s ideas throughout their narrative as they build up to the full mathematics of his equations. Rovelli reverses that and follows a path more like the one Einstein took: He lays out all the conceptual principles of relativity as clearly as possible and only after they are assembled works to express them in mathematical language.

At times Rovelli’s treatment of the mathematical content is so terse that it is a bit opaque. That pithiness, while often a pleasure, can also lead to jumps in sophistication. For example, he presumes that the reader is familiar with action principles, the calculus of variations, and the ways those result in physical equations of motion; he quickly introduces differential forms and some aspects of tensors; and he expects that readers know how vector and tensor wave polarizations transform. Those jumps are probably essential to keep the text brief, but when new readers cannot fully reconstruct an argument, they should know that they may be missing some context.

That said, the overall result is a won-

derful display of the physics of general relativity. Rovelli unabashedly serves up his perspective on the theory and paints beautiful vistas of the physics. The book brims with surprising physical intuitions: I was delighted, for example, to come away from page 5 with a perspective on Galilean relativity, new to me, that is much more closely tied to how I think about special relativity.

General Relativity will delight many readers. Not only does Rovelli meticulously motivate the ideas that lead to the theory, but he also presents many technical, mathematical topics in their simplest possible form and then builds on them. For example, he gradually develops the discussion of curvature through its history. Similarly, he examines frame fields and their relation to the gravitational

field within the easily visualized context of a two-dimensional sphere. The book's thorough grounding in examples and simple cases is somewhat rare among general-relativity textbooks. It should be essential to those who want to understand where general relativity comes from and its conceptual core. It will also help serious students prepare for more mathematically difficult literature.

Rovelli ends his book in a novel and risky way by using the tools he has built up throughout the book to discuss the cutting edge of research in quantum gravity. Among others, he presents the thrilling idea that quantization of the gravitational field can lead to granularity in the fabric of space and time and discusses how quantum spacetimes are likely to be subject to the same quantum superposition

that enriches and complicates the foundations of all quantum systems.

Of course, the risk is that the ideas mentioned in that part of the book may turn out to be empirically wrong. But the reward is great too. Rovelli's excitement about doing research at the edge of what is known is palpable. It provides students with a rare look into researchers' ideas as they create them. That gambit continues the book's theme: It offers an accomplished scientist's carefully thought-through and distilled perspective on general relativity and engenders a sense of delight at the panoramic view that the theory provides on the geometry of spacetime.

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Annandale-on-Hudson, New York

NEW BOOKS & MEDIA

Mastering Quantum Mechanics

Essentials, Theory, and Applications

Barton Zwiebach

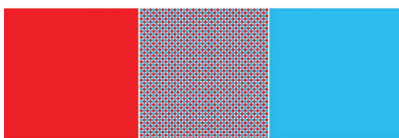
MIT Press, 2022. \$110.00

After many years of teaching quantum mechanics at MIT, theorist Barton Zwiebach has decided to produce a textbook based on his experience. The result, *Mastering Quantum Mechanics*, is encyclopedic: It clocks in at over 1000 pages long and is intended to accompany a three-semester-long course—although Zwiebach does include ideas on how to use the text for a one- or two-semester sequence. Although the book's length may overwhelm some readers, it allows Zwiebach ample room to provide clear and in-depth expositions of fundamental concepts like the Schrödinger equation, the harmonic oscillator, and the hydrogen atom.

—RD

Mastering Quantum Mechanics

Essentials, Theory, and Applications



Barton Zwiebach

The Apple II Age

How the Computer Became Personal

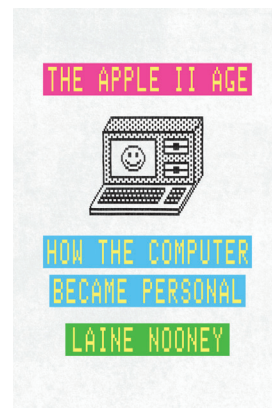
Laine Nooney

U. Chicago Press, 2023. \$28.00

Nostalgic computer hobbyists, beware! Laine Nooney is out to "rob" you of your "much-cherished

faith in computing's primordial innocence" by deconstructing the mythology surrounding the Apple II, the first personal computer to gain widespread market appeal. To do so, they look at five pieces of software—VisiCalc, the first spreadsheet program; Mystery House, the first graphical adventure game; Locksmith, a disk-copy utility; the Print Shop, a layout program that allowed users to create printed material; and Snooper Troops, an educational game intended to teach students deductive reasoning. Using contemporary hobbyist and trade magazines as a source base, Nooney demonstrates that the personal-computing revolution of the 1970s and 1980s was more a product of the "financial interests of an elite investor class" than the stereotypical Silicon Valley hacker.

—RD **PT**



Lost Women of Science

Lost Women of Science

Katie Hafner and Carol Sutton Lewis, hosts

PRX and *Scientific American*, 2023 (Season 6)

Inspired by Christopher Nolan's recent biopic *Oppenheimer*, the latest season of the *Lost Women of Science*

podcast focuses on the women of the Manhattan Project. Indeed, hundreds of female scientists made substantial contributions both to the design and fabrication of the nuclear weapons themselves and to the debate about whether they should be used against Japan. The first episode of the season focuses on Leona Woods, the only woman scientist on the team led by Enrico Fermi that built the first sustaining nuclear reactor, Chicago Pile-1. Later episodes focus on Frances Dunne, Carolyn Parker, Lilli Hornig, and Melba Phillips, among others. The bite-size episodes are each about 10 minutes in length.

—RD