A comprehensive introduction to the cosmos FREE

Cosmology for the Curious. , Delia Perlov and Alex Vilenkin, Springer, 2017, $39.99

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Physics Today **71** (4), 55–56 (2018);
https://doi.org/10.1063/PT.3.3899

NASA

A CLUSTER OF YOUNG STARS energizing the cool gas surrounding them in the NGC 6357 region of space.

A comprehensive introduction to the cosmos

Cosmology has always been a subject of fascination. Perhaps the draw is the nature of the subject matter—its profound philosophical underpinnings and its enormous scales of time and distance, which transcend our day-to-day experience. The field has experienced rapid intellectual progress during the past two decades. A proliferation of books on cosmology, ranging from technical texts to books aimed at the lay reader, are tapping into the robust interest in the subject.

Given the number of existing books, one might wonder if yet another volume on cosmology is necessary. Interestingly, it is. I teach an introductory cosmology course for nonscience majors, and it's been quite a challenge to find a textbook pitched at bright undergraduates who may not be mathematically adept but who are keen to learn about the key ideas in modern cosmology. Now Delia Perlov and Alex Vilenkin have filled that critical niche.

Cosmology for the Curious offers a comprehensive introduction to the cosmos that deftly bridges the gap between textbooks aimed specifically at advanced undergraduates, such as Barbara Ryden's excellent *Introduction to Cosmology* (2nd edition, 2016), and more narrative introductions aimed at a much broader audience, such as my recent book *Mapping the Heavens: The Radical Scientific Ideas That Reveal the Cosmos* (2016). Perlov and Vilenkin's book is also extremely useful for the scientist who is not working in cosmology but who wants to get a broad overview of its main concepts.

Part 1 of the book, titled "The Big Bang and the Observable Universe," presents the standard lore concerning the formation and evolution of structure in the universe and clearly explains how we have inferred the properties of the cosmos from astronomical data. Because our understanding of the cosmos is based on measurements of the single universe that we inhabit and because the epoch some theorists posit to exist before the Big Bang cannot be accessed via familiar empirical methods, testing our ideas about the very early universe is challenging. Perlov and Vilenkin discuss this issue and present ongoing attempts to resolve the difficulty. In part 2, titled "Beyond the Big Bang," the authors present the idea of inflation. They cover the various flavors of inflation theory and problems with those models. They also briefly discuss how string theory approaches the pre-inflationary epoch and introduce the idea of the multiverse.

The narrative strikes the right balance between what is securely established and what is scientific speculation, and it makes a point of clearly defining that boundary. Perlov and Vilenkin's willingness to address many of the field's open questions and to assess the limitations of our current comprehension of early-universe physics makes their book stand out from previous introductory texts. *Cosmology for the Curious* also discusses the deep philosophical and epistemic questions that cosmology raises. You are unlikely to find another cosmology textbook that has a chapter titled "A Proof of God?"

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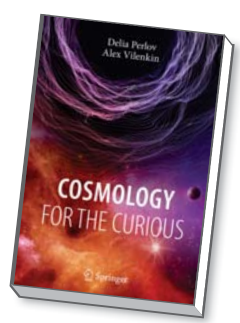

Given how comprehensive the book is, I was rather surprised that chapter 21, whose subject is the possibility of life on other planets, omitted the Drake equation and did not discuss the Fermi paradox. My only other quibble is with the black-and-white photographs of key scientists that are interspersed throughout the book. I can see that this was likely an attempt to humanize scientific research in cosmology, but the photographs mostly serve as a stark reminder of the peculiar demographics of our field. In my opinion, it would have been best to stick to pictures of the incredible instruments that have enabled cosmology's amazing discoveries. Speaking of imagery, some of the schematic figures are fantastic. Figure 16.6 explaining true and false vacuum is a gem.

To conclude, *Cosmology for the Curious* offers an excellent tour of the key ideas in cosmology. It also crisply delineates our empirically determined understanding from more speculative areas of current research. I am currently using it in my introductory cosmology class.

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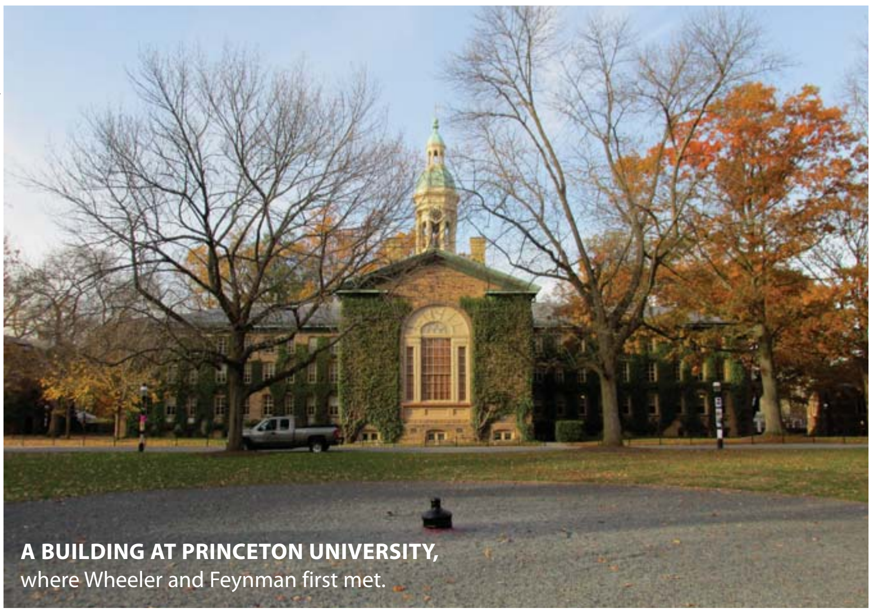
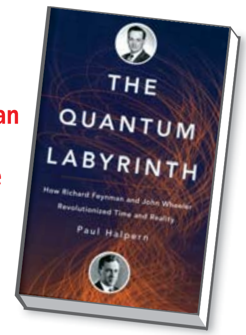


A BUILDING AT PRINCETON UNIVERSITY, where Wheeler and Feynman first met.

Entertaining biography lacks rigorous history

The Quantum Labyrinth
How Richard Feynman and John Wheeler Revolutionized Time and Reality

Paul Halpern
Basic Books, 2017.
$30.00



In the fall of 1939, Richard Feynman and John Archibald Wheeler, two of the most formidable physicists of the 20th century, began an extraordinarily fruitful collaboration. Their lifelong friendship resulted not only in groundbreaking work on electrodynamics but also in personal growth—Feynman learned how to think like a physicist and Wheeler became a gifted and proficient mentor—that influenced the course of physics over their lives.

In *The Quantum Labyrinth: How Richard Feynman and John Wheeler Revolutionized Time and Reality*, physicist and science writer Paul Halpern offers an accessible narrative that describes the Wheeler–Feynman relationship and its impact on US physics in the 20th century. That achievement is no small feat, since prose lacks the precision of mathematics. Indeed, Halpern's skillful use of analogy reminds me of two celebrated lecture series given by his subjects: the Physics for Poets course that Wheeler taught at Princeton University in the early 1970s and the Character of Physical Law lectures that Feynman gave at Cornell University in 1964.

As in Halpern's previous book, *Einstein's Dice and Schrödinger's Cat: How Two Great Minds Battled Quantum Randomness to Create a Unified Theory of Physics* (2015), *The Quantum Labyrinth* discusses the interaction of two remarkable intellectuals. A key difference in the stories is that the relationship between Erwin Schrödinger and Albert Einstein collapsed under the pressure of professional competition, whereas Wheeler and Feynman remained close friends until the latter's death.

There are, however, problematic passages in *The Quantum Labyrinth*. One issue is Halpern's tendency to overstate the importance of Feynman and Wheeler. For instance, Halpern writes, "Arguably, much of the visionary work in theoretical physics in the late-twentieth and twenty-first centuries derives from their [Feynman and Wheeler's] bold discourse, including the basis of the Standard Model of particle physics and all manner of astrophysical concepts, such as the properties of black holes and wormholes."

Unfortunately, that assertion risks trivializing the important contributions of physicists who were not part of Wheeler's intellectual lineage. Steven Weinberg and Murray Gell-Mann immediately come to mind in the context of the standard model. Similarly, Halpern's claim ignores the contributions that George Gamow and Stephen Hawking, among others, made to our understanding of astrophysics and cosmology. Halpern states, "Ultimately they [Wheeler and Feynman] reshaped the concept of time itself, allowing for alternative realities and backward journeys." Although Wheeler played a significant