

## A World Without Time: The Forgotten Legacy of Gödel and Einstein.

Hans Christian von Baeyer

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## BOOK REVIEWS

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**A World Without Time: The Forgotten Legacy of Gödel and Einstein.** Palle Yourgrau. 210 pp. Basic Books—Perseus Books Group, New York, 2005. Price \$24.00 ISBN 0-465-09293-4. (Hans Christian von Baeyer, Reviewer.)

Kurt Gödel (1906–1978) has been called “the greatest logician since Aristotle” and “the only one...who walked and talked on equal terms with Einstein” at the Institute for Advanced Study in Princeton, N.J. Nevertheless, beyond his celebrated incompleteness theorem of 1931 the general public knows next to nothing about this giant of 20th century thought. The World Year of Physics 2005 provides a fitting occasion for the publication of an account of his friendship with Einstein and of their common philosophical interests.

The author, a Brandeis University philosophy professor, is well prepared for the task. His 1991 book, *The Disappearance of Time: Kurt Gödel and the Idealistic Tradition in Philosophy*, appeared in a second, expanded edition in 1999 under the title *Gödel Meets Einstein: Time Travel in the Gödel Universe*. In contrast to these professional monographs, *A World Without Time* is intended for, and accessible to, a general audience.

The first half of the book sketches Gödel’s life in the intellectual hothouse of Vienna. Although neither he nor his wife were Jewish, the Nazi domination of Austria was increasingly constraining their lives. At the same time, Gödel had begun to suffer from the depressions and eating disorders that eventually took his life. After three temporary visits to Princeton, where Einstein was already established, and repeated invitations to join the Institute permanently, he finally decided to flee Vienna in March 1940, at the last possible moment.

Inevitably, his eponymous incompleteness theorem plays a central role in this narrative. Crudely stated, it was the astonishing discovery that in a mathematical system such as ordinary arithmetic there exist assertions that are true, but not provable. Yourgrau supplies a nontechnical sketch of the proof of this theorem in a manner that differs from countless other popularizations. As a philosopher, he takes pains to distinguish among three levels of mathematical language. At the bottom we find arithmetic as we learned it in school. Above that, formal, mathematical versions recast arithmetic in symbolic representations that are more rigorous, but unrecognizable to nonmathematicians. Finally, at the top, there are metamathematical statements ABOUT the formal systems. Gödel’s great contribution to mathematics was the realization that nimble manipulation of the relationships among these levels of expression can yield surprising insights. But even with this clarification, and Yourgrau’s patient guidance, the proof of the incompleteness theorem is difficult to follow. Fortunately the author generously gives his readers permission to skip details when the argument grows too dense for them.

The second half of the book paints a vivid and sympathetic portrait of the friendship of Einstein and Gödel, whose personalities, outward appearances, and roles in the world

were, in many ways, polar opposites. Professionally, the weightiest subject of mutual interest, as advertised in the title of the book, was the nature of Time.

Since Parmenides and Plato, and continuing to this day, philosophers have struggled with the question of the reality of time. For Gödel, time was simply *the* philosophical problem, and therefore worthy of his attention. Einstein, on the other hand, understood the immense difficulty of the concept, and therefore tried to dodge the responsibility for dealing with it. Squeezed between the imagined future and the remembered past, the intervening *now* is related to the question of existence itself. “The now means something special for man,” Einstein once told the Viennese philosopher Rudolf Carnap, “something physics cannot speak to.” But Gödel would not let his friend off so easily. **As a present for Einstein’s seventieth birthday, in 1949, he published a proof, based on no lesser authority than the theory of General Relativity, that time does not exist.**

Gödel was a logician, a mathematician, and a metaphysician, but not a physicist. That **he nevertheless found a novel solution of Einstein’s equations** to describe a hypothetical model of the cosmos called the Gödel Universe demonstrates his **astounding mathematical prowess**. He had studied physics at the University of Vienna and maintained an active interest in it. Yourgrau remarks aptly: “*Active interest* in Gödel’s case means a level of competence that for any normal person would constitute a career.” In any case, the new solution was vetted by Einstein, and pronounced not only correct but important. Its implications turned out to be startling.

In contrast to the normal solution, which describes a universe in which cosmic time proceeds inexorably from a Big Bang to the present, and then to an as yet uncertain future, **Gödel’s universe contains paths of objects that return to their own past. In other words, it allows time travel.**

This is not a book about time travel, however, which explains why the phrase does not appear in its title. The emphasis is on the meaning of time—with contributions from Gödel, Einstein, and a bevy of classical and contemporary philosophers. Gödel himself, who did not seem particularly interested in time travel as such, drew the most radical conclusion. Time, he thought, by its very nature “flows,” whatever that might mean. Space, in contrast, is static and allows travel that loops back to its starting point. So a dimension in which you can move back to where you started is not really time in the usual sense. If general relativity is true, he concluded, time does not exist.

Einstein’s reaction was more guarded. “Most thinkers,” Yourgrau summarizes, “once they had recovered from the shock of Gödel’s discovery, would restrict their response to enquiring whether Gödel’s universe was sufficiently realistic ...to be taken seriously.” Einstein, in this case, sided with most thinkers. Physicists, it seems, are less sure than Gödel of the universal applicability of general relativity.

In these passages of the book Yourgrau is at his professional best. He distinguishes among the several senses of the word time. At the bottom is the intuitive time in which we all live. Then there is Newton’s absolute time, which Einstein

replaced with the time of special relativity, and later with that of general relativity. Cosmology contributed cosmic time, and Gödel closed loops in time. Each of these concepts has problems of its own. Again distinguishing between different levels of language, Gödel examined the relationships among intuitive time, relativistic time, and philosophical time. The similarities and differences between Gödel's approaches to arithmetic and to time animate the heart of the book.

Historians of science would lament two lapses that do not, however, affect the main argument. Yourgrau repeats the claim that the mathematician David Hilbert anticipated Einstein's field equations of general relativity by 5 days, but since 1997 this version of history has been controversial, if not disproved. More puzzling is his recurring description of Einstein's unsuccessful unified field theory as an attempt to "unite the domain of quantum mechanics with general relativity." It was not. Einstein tried something much more modest—to geometrize electromagnetism in the way he had geometrized gravity, and thereby to unify the two fundamental forces we experience directly with our senses.

Running through Yourgrau's book is a subtext I cannot assess. Interwoven with its fascinating and moving story there is a polemic to establish Gödel as a philosopher. As a logician his stature is pre-eminent, and as an amateur physicist he has probably never had an equal. In language that

occasionally verges on outrage, Yourgrau insists that Gödel has been slighted as philosopher by the profession. "In What Sense is Gödel (or Anyone Else) a Philosopher?" is the title of the last chapter. The answer for Yourgrau is clear: "The case for Gödel as philosopher is unassailable." But apparently others have assailed it. To an outsider, the debate is reminiscent of a family squabble witnessed across a backyard fence. You hear the words, and learn a lot about human nature, but you lack the deep understanding that would allow you to take sides. It must be left to others to decide whether Yourgrau has made the case for Gödel, but this book substantially addresses the never-ending search for the real meaning of that perplexing, ubiquitous, elusive word: *time*. For that reason, and because it fills an important niche on the groaning shelf of Einsteiniana, this book is warmly recommended to physicists and the lay public.

*Hans Christian von Baeyer is a Chancellor Professor of Physics at the College of William and Mary in Williamsburg, VA. He wrote about time in another context in Warmth Disperses as Time Passes: The History of Heat (The Modern Library, 1999). His latest book for the general public is Information: The New Language of Science (Harvard University Press, 2004).*

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