

PHYSICS

Clockwork cosmos

Pedro Ferreira ponders a vision of the Universe in which time is paramount.

Theoretical physicist Lee Smolin's recent books have been about crises in physics so catastrophic that physicists need to completely rethink their methods. In his 2006 book, *The Trouble with Physics* (Houghton Mifflin), he stated controversially that a cabal of researchers working on what he thought was a moribund theory of fundamental physics — string theory — was preventing a new generation of clever young thinkers from working on other, rival theories. Through his brilliant writing and articulate arguments, readers took him seriously. One string theorist told me that he struggled to convince non-physicists that he wasn't a charlatan after the publication of Smolin's book.

Now, in *Time Reborn*, Smolin attempts to chip away at basic theories of modern physics. He makes the case that by doing away with time, existing theories are missing a trick. He uses the orbits of planets in the Solar System as an example: each orbit is an ellipse existing in three dimensions. A planet will lie, at some moment, on a point along that track. But its motion can be described without knowing what happens at that particular moment, or at any other. Newtonian physics is essentially timeless.

According to Smolin, our picture of a timeless Universe stems from the assumption that all modern physics — quantum as well as classical — is predictive. How a system evolves is entirely encoded in the starting set of 'initial conditions' and their transformation according to the laws of physics. Evolution in time is



Time Reborn: From the Crisis in Physics to the Future of the Universe
LEE SMOLIN
Houghton Mifflin Harcourt:
2013. 352 pp. \$28, £20

secondary, a by-product of the theory. This bothers Smolin. A timeless view of reality is, he says repeatedly, incomplete (where do the initial conditions or laws come from?) and, simply, "wrong". He believes that a

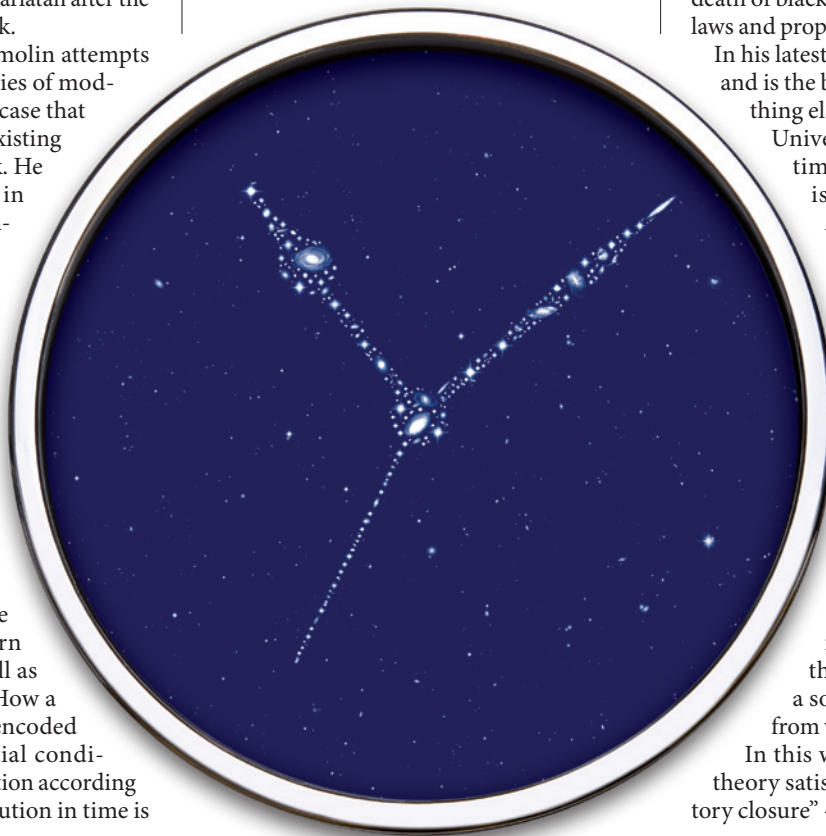
better description of time lies at the heart of some of the big questions, such as the marriage of quantum physics and general relativity.

Smolin sketches an alternative path for modern physics. Inspired by the ideas of Brazilian philosopher and political theorist, Roberto Mangabeira Unger, who argues that social structures emerge without an underlying natural order or guiding principle, Smolin develops some of the ideas behind his first book, *The Life of the Cosmos* (Oxford University Press, 1997). In it, he argued that the Universe evolved through natural selection, mediated by the birth and death of black holes, to give us the physical laws and properties we measure today.

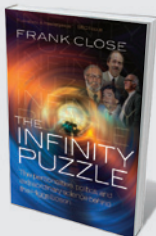
In his latest vision, time reigns supreme and is the backbone from which everything else emerges. Each state of the Universe pops up somewhere in time, from what the Universe is made of to what it does.

A prime example is space, which — echoing some of the ideas put forward by different schools of quantum gravity — emerges not as a fundamental entity, but as a tapestry of connections between events happening over time. More importantly for Smolin, none of the laws or principles that we have discovered over the centuries constitute the bedrock of physics, nor are any perennial. On the contrary, they emerge in a somewhat unpredictable way from what is going on at each time.

In this way, he says, his embryonic theory satisfies a "principle of explanatory closure" — there is no need to invoke



ALEX ROBBINS/SHUTTERSTOCK



The Infinity Puzzle: The Personalities, Politics, and Extraordinary Science Behind the Higgs Boson

Frank Close (Oxford Univ. Press, 2013; £10.99)
Particle physicist Frank Close pins down the elusive Higgs boson in this account of the search that led up to its 2012 discovery. With a Nobel prize in the offing, the vexed question of credit adds edge. (See Edwin Cartlidge's review: *Nature* **478**, 315–316; 2011.)



Feynman

Jim Ottaviani and Leland Myrick (*First Second*, 2013; \$19.99)

The playful creativity and genius of theoretical physicist Richard Feynman are brilliantly brought to life in Jim Ottaviani's graphic biography, illustrated by Leland Myrick. (See Marc Weidenbaum's Q&A: *Nature* **477**, 32; 2011.)

any external laws or initial conditions.

It is a tall order, and if Smolin's theory is to work, then all the great experimental discoveries in physics — from elliptical planetary orbits to the Higgs boson — need to be incorporated. Hallowed theories such as quantum physics and relativity must be dismantled and some radically new way of explaining how the Universe evolves must come into play. Smolin shies away from actually telling us what that new way is, because he doesn't seem to know himself. All he can do is to explain how different his theory must be from everything we have done before.

To explain why anything can be predicted at all in such a lawless Universe, Smolin invokes reproducibility: if a physical process has happened in a certain way before, it will happen in the same way again. We can predict what will happen if we have some familiarity. But, Smolin notes, there will be situations that we have never seen before, in which it will be impossible to predict the outcome.

Writing a book is a well-worn way of presenting a provocative theory that is still in its infancy. Smolin, a respected physicist with a track record of best-sellers, has a privileged platform for promoting his ideas, similar to Arthur Eddington, Erwin Schrödinger or Fred Hoyle before him. Books can, however, feel reckless without the filter of the (albeit flawed) peer-review process.

Yet I enjoyed *Time Reborn*. Smolin is an excellent writer, a creative thinker and is ecumenical in the way he covers so many different branches of thought. Even as I mentally argued with this book, I kept on ploughing through to see how Smolin dealt with the objections. I would love to sit down with him over a drink and debate the ins and outs of his theory. And that is how this book should be read: as an account that makes you ask questions. ■

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NEUROSCIENCE

Drugs to build a better brain

Anjan Chatterjee probes a cognitive-enhancement primer.

Decisions can be as trivial as which coffee to order or which wine to buy, or as consequential as who to marry or which job to accept. Yet even the most profound choices are rarely made on strictly logical grounds. We don't weigh up pros and cons and dispassionately pick the best course of action. Our emotions and attitude to risk, how a situation is framed and the time available all influence our final choices.

In *Bad Moves*, Barbara J. Sahakian and Jamie Nicole Labuzetta lay out the neuroscience of how people make decisions and the ethical quandaries that accompany the use of drugs to enhance cognition. Their slim book is admirable in reviewing these important topics, but it does little to explore the wider view of how emotions can be regulated by drugs.

Sahakian, well known for her research on the neuropsychology of affective and cognitive systems, and neurologist Labuzetta use people with dementia, depression, mania and phobias, who tend to make poor

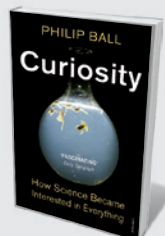


Bad Moves: How Decision Making goes Wrong, and the Ethics of Smart Drugs
BARBARA J. SAHAKIAN AND JAMIE NICOLE LABUZETTA
Oxford University Press: 2013. 192 pp. £14.99

decisions, as exaggerated examples of how we can all err. Abnormal functioning of the frontal lobes and deep limbic structures in the brains of people with these disorders disrupts their emotional control and thus decision-making ability.

After discussing decision-making processes in the brain, Sahakian and Labuzetta explore cognitive enhancers. They focus on cholinesterase inhibitors and stimulant medications that can improve memory, sharpen attention and boost concentration. Such 'smart drugs' raise an ethical question: if drugs developed to treat people with

ILLUSTRATION BY ALEX ROBBINS



Curiosity: How Science Became Interested in Everything

Philip Ball (Vintage, 2013; £9.99)
Humanity's burning urge for knowledge drives science. Philip Ball's scintillating history of curiosity brims with treats — such as seventeenth-century philosopher Francis Bacon's use of a Pan myth as an allegory for the quest to learn from nature.



Genentech: The Beginnings of Biotech
Sally Smith Hughes (Univ. Chicago Press, 2013; \$16)

The history of Genentech, the company that kick-started the biotech industry, is compellingly told by Sally Smith Hughes. Studded with in-depth portraits of its pioneers. (See Linnaea Ostroff's review: *Nature* **478**, 456; 2011.)