Resetting the Clocks

‘Time Reborn,’ by Lee Smolin

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Published: May 3, 2013

In one of the more fanciful conceptions of nature, the British physicist and philosopher Julian Barbour proposed that the world is just a “heap of moments,” each an instant of frozen time. There is no order to the moments, no sequence, no cause-and-effect relationship. We exist only from moment to moment. If we experience time passing, it’s because this particular moment has memories of another moment woven into it. Some moments are interesting: they contain complexity, stars and planets, life. Others are boring: they contain only energy, or perhaps nothing at all.

In his new book, “Time Reborn,” Lee Smolin, a physicist and author of “The Life of the Cosmos” (1997) and “The Trouble With Physics” (2006), recounts Barbour’s cosmology with some admiration and then goes on to offer even more radical ideas of his own. Smolin argues that the Now has been taken out of physics, and it is time to put it back in. For example, Smolin says that Newtonian physics expresses the notion that the future is determined by the past and so, in a sense, the future already exists. He rightly remarks that Einsteinian physics frames time as a relative concept in which the line between past and future varies with the observer. To remedy these perceived problems, he suggests major structural revisions to the two fundamental pillars of modern physics, relativity and quantum mechanics. His book, a mix of science, philosophy and science fiction, is at once entertaining, thought-provoking, fabulously ambitious and fabulously speculative. Although full of wonderful metaphors and analogies, it may prove heavy sledding for many readers. Twentieth-century physics has brought us two kinds of strangeness: strange things we more or less understand, and strange things we do not understand. The first category includes relativity and quantum mechanics. Relativity reveals that time is not absolute. Clocks in relative motion to each other tick at different rates. We don’t notice relativity in daily life because the relative speed must be close to the speed of light before the effects are significant. Quantum mechanics presents a probabilistic picture of reality; subatomic particles act as if they occupy many places at once, and their locations can be described only in terms of probabilities. Although we can make accurate predictions about the average behavior of a large number of subatomic particles, we cannot predict the behavior of a single subatomic particle, or even a single atom. We don’t feel quantum mechanics because its effects are significant only in the tiny realm of the atom.

The category of strange things we do not understand includes the origin of the universe and the nature of the “dark energy” that pervades the cosmos. Over the last 40 years, physicists have realized that various universal parameters, like the mass of the electron (a type of subatomic particle) and the strength of the nuclear force (the force that holds the subatomic particles together within the centers of atoms), appear to be precisely calibrated. That is, if these parameters were a little larger or a little smaller than they actually are, the complex molecules needed for life could never have formed. Presumably, the values of these parameters were set at the origin of the universe. Fifteen years ago, astronomers discovered a previously unknown and still unexplained cosmic energy that fills the universe and acts as an antigravity-like force, pushing the galaxies apart. The density of this dark energy also appears to be extraordinarily fine-tuned. A little smaller or a little larger, and the life-giving stars would never have formed.

The haunting question is why these fundamental parameters lie in the narrow range required by life. What determined their values? One explanation offered by physicists, called the "anthropic principle," is that there are, in fact, a great many universes, with widely varying properties and parameters. In most other universes, the strength of the nuclear force, the density of the dark energy and so on are much different than in ours. Those universes would be lifeless and barren. By definition, we live in one of the universes with parameters that allow life, because otherwise we would not be here to ask the question.

Smolin has his own theory to explain why we live in a life-supporting universe, which he calls "cosmological natural selection." He proposes that new universes are spawned at the centers of black holes. As in biological natural selection, those universes with the right parameters for producing new black holes have descendants; those that do not disappear. What's more, it turns out that some of the conditions needed to form black holes, such as the right parameters to form stars, are the same as those needed for life.

Despite its appeal, there are several problems with Smolin's theory. First, there is no evidence that new universes are created at the centers of black holes. Second, even if such evidence existed, why would the parameters of a universe so created bear any resemblance to the parameters of its parent universe, as required by the theory? If the parameters differ by more than a little, the new universe would not have "survivable" characteristics.

Cosmological natural selection does have one feature that relates to Smolin's dissatisfaction with the relativity of time. The succession of parent and descendant universes necessarily unfolds in time, and Smolin believes that this is "real" time (as opposed to what he calls the "unreal" and "inessential" conceptions of time in traditional physics).

He goes on to propose a variety of revolutionary ideas to codify further his notion of "real time." In one, he suggests that every atom in the universe is causally connected to every other atom in the universe, no matter how many light-years away.

According to his notion, the failure of standard quantum mechanics to predict the behavior of individual atoms arises from the fact that it does not take into account the vast numbers of interconnections extending across the universe. Furthermore, this picture of the cosmos requires an absolute time (in violation of relativity), which he calls “preferred global time.”

One of Smolin’s most astonishing ideas is something he calls the “principle of precedence,” that repeated measurements of a particular phenomenon yield the same outcomes not because the phenomenon is subject to a law of nature but simply because the phenomenon has occurred in the past. “Such a principle,” Smolin writes, “would explain all the instances in which determinism by laws work but without forbidding new measurements to yield new outcomes, not predictable from knowledge of the past.” In Smolin’s view such unconstrained outcomes are necessary for “real” time.

Putting aside the sensational ideas proposed in “Time Reborn,” it is a triumph of modern physics that we are even asking such questions as what determined the initial conditions of the universe. In previous centuries, these conditions were either accepted as given or attributed to the handiwork of the gods. A triumph, and also possibly a defeat. For if we must appeal to the existence of other universes — unknown and unknowable — to explain our universe, then science has progressed into a cul-de-sac with no scientific escape.

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TIME REBORN
From the Crisis in Physics to the Future of the Universe
By Lee Smolin

Illustrated. 319 pp. Houghton Mifflin Harcourt. $28.