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Scientists always revise old theories. That could mean new notions of both space and time.

The Next Quantum Leap

It Could Be Otherwise

By Stuart Firestein *Basic, 288 pages, $30*

On the Equality of All Things

By Carlo Rovelli *Scribner, 192 pages, $ 27*

BY ANDREW CRUMEY

STUART FIRESTEIN wants to persuade us that "science is a fundamentally optimistic enterprise." That might sound paradoxical given the terrible weapons that physicists have brought us, or the dire predictions of climatologists about earth's future. But Mr. Firestein isn't an optimist in the usual sense. He proposes "a more deeply philosophical optimism that does not necessarily make you happier or more cheerful, although . . . it should." He calls this "scientific optimism," characterizing it as being "obsessed with a future of possibilities."

Mr. Firestein is a professor of neuroscience at Columbia University who has published books on the value of ignorance and failure in science. "It Could be Otherwise" is of a similar vein, highlighting the virtue of uncertainty. "Science is the practice of uncertainty," the author writes. "Uncertainty is possibility, and possibility is optimistic."

He identifies "five strategic principles of doing science": questioning authority, being experimental, learning from failure, forming flexible hypotheses and harnessing the power of counterintuitive thinking—good principles that would not be out of place in a book on business startups. For them to be more than platitudes here, however, there need to be specific examples, and these are the best part of the book.

Mr. Firestein mentions research on a species of jellyfish that led to the unexpected discovery of a new protein now "used to uncover genes expressed in cancer cells." Meanwhile, inspiration for a crucial technique in DNA analysis came, we are told, with the help of recreational drugs. The author's own research involves measuring tiny electrical currents flowing through parts of our brain cells called ion channels. "No matter how long we observe them," he tells us, "we can never predict with certainty precisely when a channel will open or close—it is entirely probabilistic." That uncertainty gives him cause for optimism: Our brains are subject to chance, opening a world of possibility.

I would have welcomed more examples from Mr. Firestein's area of expertise. Instead, much of the book is taken up with an old-fashioned and highly questionable history of science in which people are defined by the periods they lived in. Copernicus "started, if perhaps unintentionally, the Scientific Revolution" while living in the "mushy transition from the medieval period to the Renaissance." It was the time of "the Reformation, a notably antiauthoritarian movement." Galileo "suffered reprobation from the church, not only because he supported the Copernican view," the author writes, "but because he published his antiauthoritarian, and somewhat snarky, science books in Italian" as opposed to Latin. (Actually it was Galileo's friend, the pope, who encouraged him to do so.)

Neglecting his own first principle, Mr. Firestein quotes authors without questioning their authority or offering rival views. He also fails to cite references, so I was unable to discover where the sociologist Robert Merton apparently said that (quoting here Mr. Firestein's paraphrasing), "in spite of

the occasional bright star or beacon of discovery in the earlier periods (e.g., Leonardo da Vinci, Robert Grosseteste, Roger Bacon), they were not enough to support a scientific infrastructure." Many historians would disagree; Pierre Duhem and Herbert

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Butterfield dated the start of the scientific revolution to around 1300.

Shorter, denser and more rewarding is Carlo Rovelli's "On the Equality of All Things." Mr. Rovelli is a theoretical physicist whose earlier books include "Seven Brief Lessons on Physics" (2015). Rather than seeing the world as "made of objects," he argues that it is "woven by relations."

Mr. Rovelli explains that this book emerged from lectures and discussions held while he was visiting Princeton University's philosophy department. "The best philosophers, such as Aristotle, Hume, Kant and Husserl, have always paid extremely close attention to the science of their day." Mr. Rovelli judges some of Princeton's philosophers to be not of that kind. "To me, as a scientist," he tells us, "it seemed that what they considered the reality defined by science . . . had little to do with the far more nuanced notion of reality in the actual science of our century."

What some of the Princeton philosophers imagined, according to Mr. Rovelli, was that the universe consisted of "well-defined atoms moving in an absolute space." Atoms and their constituents were assumed to be like tables and chairs; reliably solid objects that don't dance around or disappear when nobody's looking at them. A century of quantum theory has shown otherwise. "The 'particles' of particle physics," Mr. Rovelli explains, "are not particles like grains of sand: the very notion of a particle is a metaphor."

Where quantum theory has so far failed is in explaining gravitation, the force that keeps us on the ground and steers the earth around the sun. One attempt was string theory, which regarded particles as vibrations of tiny strands in space, with one kind causing gravity. Mr. Rovelli rejects this as "wild speculation." Instead he favors an approach called loop quantum gravity, which involves a new understanding of space itself.

We might think of space as an empty container in which things are located. Take away the things and the space is still there. Loop quantum gravity views it differently, in a way that, Mr. Rovelli says, was anticipated by Aristotle. "Space, in this sense, is a relation between things or events," the author observes. "There can be no space if there are no things or events, just as there is no family if there are no people who form it."

This relational view of space is also how Albert Einstein understood it, but he assumed there was no limit to how small things could be, or how close together. Quantum theory suggests there is in fact such a limit, called the Planck length. It is smaller than the width of a human hair by about the same factor that a human hair is smaller than the observable universe. What it means, Mr. Rovelli says, is that "the pieces of space are granular."

Again, this is not like grains of sand. Instead quantum theory thinks of space as a network of tiny regions. The necessary mathematics were developed as long ago as the 1970s; now the theory is being used to make predictions about black holes, which, the author reminds us, "we recently discovered the universe is full of."

Mr. Rovelli is aware that his readership will include philosophers, fellow physicists and a majority who are neither. He directs the main body of his text to the majority, and puts technical details in footnotes. Even the main text is a challenge, however, which is inevitable when the issues are so profound. What's missing is the Princeton philosophers' side of the debate. In his sardonic dismissal of their arguments, Mr. Rovelli sounds at times like Galileo, who was similarly withering about his Aristotelian colleagues. The irony is that Aristotle now appears not to have been so wrong after all. According to Mr. Rovelli, he did "excellent physics" and was "more intelligent . . . than the contemporaries I know."

Mr. Crumey is the author of the novel "Beethoven's Assassins."

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