

Carlo Rovelli. *Seven Brief Lessons on Physics*. Penguin Random House 2016. 96 pp. \$18.00 USD (Hardcover ISBN 9780399184413).

Rovelli intends to provide an accessible overview of ‘the most fascinating aspects’ of modern physics while exploring some of its remaining mysteries (vii). Rovelli realizes his principal aim, and his book, translated from the Italian (2014), appears to be an international success. But the title of his short and elegant book is misleading. The first six lessons concern physics, but the last one is an exercise in philosophy: it discusses free will, philosophy of psychology, the nature of science, and more. Given the popularity of the book, philosophers may be pleased that Rovelli is exposing the wider public to both philosophy and science.

The first six lessons are entitled ‘The Most Beautiful of Theories’ (on general relativity), ‘Quanta’ (on quantum mechanics), ‘The Architecture of the Cosmos’ (the universe’s macrocosmic structure), ‘Particles’ (on the Standard Model of elementary particles), ‘Grains of Space’ (loop quantum gravity), and ‘Probability, Time, and the Heat of Black Holes.’ The seventh and final lesson is called ‘Ourselves.’ Whereas each of the lessons is named ‘First Lesson,’ ‘Second Lesson,’ and so on, the title of the last lesson, ‘In Closing,’ stands out by not following this pattern. This is where the philosophy happens. Insofar as Rovelli engages in philosophy, the theoretical physicist appears to be most influenced by Baruch Spinoza.

Rather than summarizing the first six lessons on physics, which Rovelli gracefully presents, I will comment on some of the more philosophically interesting aspects. The first lesson describes Einstein’s general theory of relativity as ‘beautiful.’ Rovelli states that understanding Riemann’s mathematics leads to an experience of ‘sheer beauty,’ a response to its ‘wonderful simplicity.’ The book concludes with the claim that the ‘mystery and beauty of the world’ are ‘breathtaking’ (79). Such appeal to beauty is noteworthy. While the idea of the beauty of science and mathematics is not novel in the western tradition, and harkens back at least to the eighteenth century (e.g. Hutcheson) if not to Plato, the claim seems to be frequently made by scientists and mathematicians writing about or commenting on science (e.g., Ian Stewart’s *Why Beauty is Truth* and Frank Wilczek’s *A Beautiful Question*).

Rovelli’s third lesson claims that ‘before experiments, measurements, and rigorous deductions, science is above all about visions. Science begins with a vision’ (21). His book puts this point into practice. The third lesson displays many attractive, elegant drawings and images of our understanding of the cosmos. At stake is not just beauty, but truth: each drawing or illustration is more accurate than the other. Rovelli tells a story of scientific progress, even if he never clarifies whether his perspective is realist or pragmatist.

The third lesson introduces a ‘Big Bounce’ theory of the universe: ‘Was there something before [the origin of this universe]? Perhaps, yes’ (28). Rovelli picks this up in the fifth lesson. ‘Our universe may have been born from a bounce in a prior phase, passing through an intermediate phase in which there was neither space nor time’ (47). Rovelli may hesitate to characterize this as ‘metaphysics,’ but surely Kant would have characterized the discussion as touching on the antinomies of pure reason. The spatio-temporal limit of the world or universe is the topic of the first antinomy in Kant’s *Critique of Pure Reason*. Rovelli hints that he prefers a version of Aristotle’s and Spinoza’s answer: the universe does not have a beginning (at least, not one in the Big Bang). There was only a bounce. This is somewhat reminiscent of the ‘antithesis’ position in Kant’s antinomy. (An updated ‘thesis’ position of Kant’s antinomy, however, might ask if that bounce came from a previous bounce, and if that bounce did, and so on. It would claim that, to avoid an infinite regress,

one is forced to assert an origin.) But the issue is open-ended and unsettled, Rovelli observes, perhaps to be answered one day by empirical science.

Regarding the philosophy of time, Rovelli appears to prefer a ‘block’ universe theory and eternalism (all spacetime moments are equally real). He rejects presentism, the view that only the present exists or is real. Rather, past things exist as much as present ones (57). The ‘present’ does not exist in an objective sense any more than ‘here’ does (60). Rovelli prefers the view that our experience of time is caused by the limitations of consciousness, in short, by ignorance. For a hypothetically supersensible being, there would be no flow of time; the universe would be a single block of past, present, and future.

The final lesson engages even more directly with philosophical questions. The discussion ranges from the philosophy of science and knowledge, to metaphysics and the free will debate, to values and selfhood. Rovelli justly protests against anti-science sentiments in contemporary culture, and wisely admonishes opponents of the science of climate change (76). He offers more aesthetic claims, too. Whereas he had claimed that physical theories can be beautiful, now Rovelli implies that nature (stars), and even our brains, can be sublime. ‘We have a hundred billion neurons in our brains, as many as there are stars in a galaxy, with an even more astronomical number of links and potential combinations through which they can interact’ (72). The quantities of stars and of neurons mirror each other.

Rovelli has clearly studied a good deal of philosophy – he cites Lucretius, Spinoza, Kant, even Heidegger. To his credit, he is humble about his (or anyone’s) ability to answer once and for all philosophical questions about existence, selfhood, values, emotions, and knowledge (63).

Still, a few problems with his analysis deserve to be mentioned.

There is the occasional equivocation. ‘It is not against nature to be curious: it is in our nature to be so’ (75). Nature is, according to the first use, *the world explained by science* (‘the world in the light of science,’ as he puts it on p. 64) and, in the second sense, essence or *disposition*. Yet a charitable reader could overlook this.

In calling the final lesson ‘In Closing’ rather than ‘Seventh Lesson,’ Rovelli implicitly admits that the final lesson is mainly about philosophy, not science. But he is not very clear about it. After all, the book’s title mentions *seven* lessons. He appears to view himself as summarizing science in the final lesson after all. He states that he is approaching the question of human identity and selfhood from the perspective of *science* (64). This creates some confusion about what he is actually undertaking in this part of the book. (There is another, quite understandable, explanation of why he would characterize the lesson as science: he wished to use the number seven and not be stuck with six lessons.) In any case, *pace* the book’s title, the final lesson involves much more than *physics* (that is, physical science). And the questions he addresses are not answered by science alone. They require philosophy.

Rovelli offers a compatibilist view of freedom, where humans are both determined and (at the same time) free, in the sense that a person is not interfered with by ‘external’ factors. ‘To be free doesn’t mean that our behavior is not determined by the laws of nature. It means that it is determined by the laws of nature acting in our brains.’ We appear to ourselves to be free or have ‘internal liberty’ because of our own ignorance of what is happening within us (71-72). His account is indebted to Spinoza, and he cites the Dutch philosopher. But Rovelli is Spinozist in other areas. He offers a Spinoza-like view of the universe’s ‘bouncing.’ His philosophy of nature, too, draws on Spinoza: everything is nature. We too are nature. ‘We are an integral part of nature; we are nature, in one of its innumerable and infinitely variable expressions ... That which makes us specifically human does not signify our separation from nature; it is part of that self-same nature’ (74).

Rovelli's characterization of science is either realist or pragmatist; he does not clarify which one he favors. His account in the third lesson (on the various understandings of the cosmos) seems realist (66), a story of progress. On the other hand, he suggests at times that science is a matter of being *good enough*: 'if we are good enough we will get it right and will find what we are seeking' (67). The border between myth and science, he claims, is 'porous' (67). This seems much more pragmatist.

I conclude by observing an irony that concerns Rovelli's characterization of his own project. He throws a quick jab at the German idealist, Schelling. 'During the great period of German idealism, Schelling thought that humanity represented the summit of nature, the highest point, where reality becomes conscious of itself. Today, from the point of view provided by our current knowledge of the natural world, this raises a smile' (65). I leave aside whether this is an accurate reading of Schelling and what the idealist's 'summit of nature' claim would mean. The issue goes deeper than Schelling interpretation. Rovelli's statement may be construed as leading to or implying a performative contradiction (like saying 'I am silent'). Isn't Rovelli committed to the claim that science, by understanding nature, adds to our self-understanding, hence to a kind of self-consciousness? In his book, Rovelli summarizes six ways or lessons in which nature (i.e. humanity) becomes conscious of itself. 'We, human beings,' he writes, 'are first and foremost the subjects who do the observing of this world; the collective makers of the photograph of reality which I have tried to compose' (64). He thinks this is true at the individual level too: the so-called 'I' reflects upon itself, and is formed through 'self-representations in the world' (72). Given that Rovelli, like Spinoza, holds that everything (including humanity) is nature, it is ironic that he smiles condescendingly at one of the German idealists, who too were inspired by Spinoza, and who were so interested in telling a compelling story of how nature (we) became self-conscious, that is, came to know ourselves better. While a naturalistically and experimentally inclined scientist such as Rovelli would find it difficult to accept many of the idealists' arguments, surely his book demonstrates that he is committed to a similar project of self-knowledge, of 'nature' knowing itself through different kinds of representations, images, illustrations, maps, and concepts. Rovelli's point of course was simply that humanity does not have a *special* kind of status in the universe, and the point is easily granted. But it is somewhat ironic that Rovelli smiles at Schelling's project, when his own endeavor is similar in the noted respect.

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