



YOUR KINDLE NOTES FOR:

## The Order of Time

by Carlo Rovelli

Free Kindle instant preview: <http://amzn.asia/eK8LYwU>

### 9 Highlights

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Highlight (Yellow) | Location 97

Perhaps, as in the first and greatest of all detective novels, Sophocles' Oedipus Rex, the culprit turns out to be the detective.

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Highlight (Yellow) | Location 119

The ability to understand something before it's observed is at the heart of scientific thinking. In antiquity, Anaximander understood that the sky continues beneath our feet long before ships had circumnavigated the Earth. At the beginning of the modern era, Copernicus understood that the Earth turns long before astronauts had seen it do so from the moon. In a similar way, Einstein understood that time does not pass uniformly everywhere before the development of clocks accurate enough to measure the different speeds at which it passes.

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Highlight (Yellow) | Location 212

The difference between past and future, between cause and effect, between memory and hope, between regret and intention . . . in the elementary laws that describe the mechanisms of the world, there is no such difference.

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Highlight (Yellow) | Location 231

Sadi's pamphlet finds its way into the hands of a fierce-eyed, austere Prussian professor called Rudolf Clausius. It is he who grasps the fundamental issue at stake, formulating a law that was destined to become famous: if nothing else around it changes, heat cannot pass from a cold body to a hot one. The crucial point here is the difference from what happens with falling bodies: a ball may fall, but it can also come back up, by rebounding, for instance. Heat cannot. This is the only basic law of physics that distinguishes the past from the future. None of the others do so. Not Newton's laws governing the mechanics of the world; not the equations for electricity and magnetism formulated by Maxwell. Not Einstein's on relativistic gravity, nor those of quantum mechanics devised by Heisenberg, Schrödinger, and Dirac. Not those for elementary particles formulated by twentieth-century physicists. . . . Not one of these equations distinguishes the past from the future.<sup>11</sup> If a sequence of events is allowed by these equations, so is the same sequence run backward in time.<sup>12</sup> In the elementary equations of the world,<sup>13</sup> the arrow of time appears only where there is heat.\* The link between time and heat is therefore fundamental: every time a difference is manifested between the past and the future, heat is involved. In every sequence of events that becomes absurd if projected backward, there is something that is heating up.

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Highlight (Yellow) | Location 247

Only where there is heat is there a distinction between past and future. Thoughts, for instance, unfold from the past to the future, not vice versa—and, in fact, thinking produces heat in our heads. . .

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Highlight (Yellow) | Location 407

“Basketball champions” refers to a team of basketball players, not to footballers. Monetary profit refers to human society, not to swallows. The notion of “the present” refers to things that are close to us, not to anything that is far away. Our “present” does not extend throughout the universe. It is like a bubble around us. How far does this bubble extend? It depends on the precision with which we determine time. If by nanoseconds, the present is defined only over a few meters; if by milliseconds, it is defined over thousands of kilometers. As humans, we distinguish tenths of a second only with great difficulty; we can easily consider our entire planet to be like a single bubble where we can speak of the present as if it were an instant shared by us all. This is as far as we can go.

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Highlight (Yellow) | Location 787

Let me reprise the long dive into the depths made in the first part of this book. There is no single time: there is a different duration for every trajectory; and time passes at different rhythms according to place and according to speed. It is not directional: the difference between past and future does not exist in the elementary equations of the world; its orientation is merely a contingent aspect that appears when we look at things and neglect the details. In this blurred view, the past of the universe was in a curiously “particular” state. The notion of the “present” does not work: in the vast universe there is nothing that we can reasonably call “present.” The substratum that determines the duration of time is not an independent entity, different from the others that make up the world; it is an aspect of a dynamic field. It jumps, fluctuates, materializes only by interacting, and is not to be found beneath a minimum scale. . . . So, after all this, what is left of time?

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Highlight (Yellow) | Location 827

The difference between things and events is that things persist in time; events have a limited duration. A stone is a prototypical “thing”: we can ask ourselves where it will be tomorrow. Conversely, a kiss is an “event.” It makes no sense to ask where the kiss will be tomorrow. The world is made up of networks of kisses, not of stones.

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Highlight (Yellow) | Location 1764

Will we be able to understand things better in the future? I think so. Our understanding of nature has increased vertiginously over the course of centuries, and we are continuing to learn. We are glimpsing something about the mystery of time. We can see the world without time: we can perceive with the mind’s eye the profound structure of the world where time as we know it no longer exists—like the Fool on the Hill who sees the Earth turn when he sees the setting sun. And we begin to see that we are time. We are this space, this clearing opened by the traces of memory inside the connections between our neurons. We are memory. We are nostalgia. We are longing for a future that will not come. The clearing that is opened up in this way, by memory and by

anticipation, is time: a source of anguish sometimes, but in the end a tremendous gift. A precious miracle that the infinite play of combinations has unlocked for us, allowing us to exist. We may smile now. We can go back to serenely immersing ourselves in time—in our finite time—to savoring the clear intensity of every fleeting and cherished moment of the brief circle of our existence. THE SISTER OF SLEEP The brief arc of our days, O Sestius, prevents us from launching prolonged hopes.

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