



## The Order of Time

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Shiva's role as creator, preserver, and destroyer of the universe also conveys the Indian conception of the never-ending cycle of time. [1]

With this image Carlo Rovelli opens his poetically written book about “the nature of time, the greatest mystery of mankind: Do we live in time or is time in us?”

Rovelli refers to Anaximander of Milet (610-545 BC), a pioneer for search of the beginning of the world, introducing the order of “chronos” (time):

“Things are transformed one into another according to necessity, and render justice to one another according to the order of time” (Anaximander). This is probably the first time a concept of ordered movement appears in the history of philosophical ideas.

With this introduction Rovelli leads the reader through three parts, (1) the crumbling of time, (2) the world without time and (3) the sources of time, providing an up-to-date presentation of the major historical known thoughts about revealing the mystery of time and Rovelli puts them in connection with his own experience and interpretation.

Rovelli’s single mathematical formula presented in the entire book is:

$$\Delta S \geq 0.$$

It defines increase of entropy (S) in a hot body, that will gradually cool off by increasing - and only increasing - if left alone (2<sup>nd</sup> law of thermodynamics), thus the link of time to the loss of heat is essential, because also time is pointing like an arrow in only one direction and is irreversible.

Rovelli gently leads us through the various genius thoughts in history about time, going all the way back to Aristotle “time is the measurement of change - if nothing changes there is no time”. Newton acknowledges a common notion of time that measures days and movements, but also believes in a “true time”. “True time” passes regardless, independently of things and of their changes. If all things remained motionless and even the movements of our souls were to be frozen, this time would continue to pass, according to Newton, unaffected and equal to itself. It’s the exact opposite of what Aristotle writes.

A similar discussion ensued over „space“: Aristotle was the first to discuss in depth and with acuity the meaning of “space,” or “place,” and to arrive at a precise definition: “the place of a thing is what surrounds that thing”.

Newton suggests that we should think differently. Space defined by Aristotle, the enumeration of what surrounds each thing, is called “relative, apparent, and common” by Newton. He defines “absolute, true and mathematical” space in itself, which exists even where there is nothing.

The reconciliation of those conflicts required a third party: Einstein. This “three-handed dance of these intellectual giants—Aristotle, Newton, and Einstein—has guided us to a deeper understanding of time and of space” according to Rovelli.

The synthesis between Aristotle’s time and Newton’s time is the most valuable achievement made by Einstein. It is the crowning jewel of his thought according to Rovelli.

The answer is, time and space Newton had intuited the existence of, beyond tangible matter, do effectively exist. They are real. Time and space are real phenomena. But they are in no way absolute; they are not at all independent from what happens; they are not as different from the other substances of the world, as Newton had imagined them to be.

Physicists call “fields” the substances that, to the best of our knowledge, constitute the weave of the physical reality of the world. Spacetime is the gravitational field—and vice versa. It is something that exists by itself, as Newton intuited, even without matter.

Einstein wrote the equations of the gravitational field in 1915, and barely a year later it is Einstein himself who observes that this cannot be the last word on the nature of time and space, because of the existence of quantum mechanics. The gravitational field, like all physical things, must necessarily have quantum properties.

Rovelli now embarks in his own field of research called “quantum gravity,” explaining the three fundamental discoveries of quantum mechanics: (1) granularity, (2) indeterminacy, and (3) the relational aspect of physical variables. Each one of these demolishes further the little that was left of our idea of time.

In Part III of the book “World without time” Rovelli explains in plausible terms of quantum mechanics language “that the world is a network of events... and a ceaseless process of change” and “the world is not a collection of things but a collection of events”. If by “time” we mean nothing more than happening, then everything is time.

The following chapter addresses the question of how does one describe a world in which everything occurs but there is no time variable? The answer is given by the Wheeler–DeWitt equation: “The theory does not describe how things evolve in time. The theory describes how things change one in respect to the others, how things happen in the world in relation to each other. That’s all there is to it.”

As a relief for the reader, in the chapter “Sources of time” and “Sister of Sleep” Rovelli admits “up to this point, it has been a time to destroy time. Now it is time to rebuild the time that we experience: to look for its sources, to understand where it comes from”, gradually leading us to more “human things”.

After excursions into quantum time and other philosophical explanations Rovelli comes to the conclusion, there are “many times” depending on our specific perspectives, time is determined by the law of increasing entropy and the universe is not following a timeline but manifests itself as a summary of events.

Any process starting with low (ordered) entropy and indispensable striving for increasing entropy is the real “dance of Shiva”.

The last chapters of the book deal with our human identity and our emotions as associated with our “blurred” perception of time being caught between the past and future.

From our perspective—the perspective of creatures who make up a small part of the world—we see a world flowing in time. Our interaction with the world is partial, which is why we see it in a blurred way.

The last chapter explains and sums up the author’s philosophical view of our world:

The world does not consist of objects but of events, time is within us and is flowing because our brain retains the memories of the past and generates expectations for the future, there is no “present” time, like “here” and “now” ...and time touches us emotional, it is not a neutral notion:

“There is a time to live and a time to die”.

There is no fundamental time, only change, no change - no time.

“This is time for us: a multilayered, complex concept with multiple, distinct properties deriving from various different approximations. Many discussions of the concept of time are confused because they simply do not recognize its complex and multilayered aspect. They make the mistake of not seeing that the different layers are independent.”

This is the physical structure of time as Rovelli understands it, after a lifetime of revolving around it.

I appreciate this book very much and recommend it to all readers interested in this subject: it literarily widens your horizon on the universe and gives you a deep insight in all physical and philosophical questions which have been thought out, some of them false, many true and still valid but not yet covering the whole picture. Sometimes it even looks that unbelievable ideas have been thought over and over again through the centuries before they became common sense (in our world).

Rovelli's talent is to communicate his message in an eloquent, plausible and poetic language. Easy to read, sometimes not so easy - but always convincing as a possible alternative for our way to look deeper and deeper in the "mystery of time".

## Reference

[1] Shivas Dance:

<https://www.metmuseum.org/art/collection/search/39328#:~:text=Shiva's%20dance%20is%20set%20within,the%20gesture%20that%20allays%20fear>).

October 2020, Joachim J. Kehr, Editor SpaceOps News for the Journal of Space Operations & Communicator  
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