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# Yet another time about time … Part I: An essay on the phenomenology of physical time

Plamen L. Simeonov

*JSRC, Berlin, Germany*

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A B S T R A C T

This paper presents yet another personal reflection on one the most important concepts in both science and the humanities: *time*. This elusive notion has been not only bothering philosophers since Plato and Aristotle. It goes throughout human history embracing all analytical and creative (anthropocentric) disciplines. Time has been a central theme in physical and life sciences, philosophy, psychology, music, art and many more. This theme is known with a vast body of knowledge across different theories and categories. What has been explored concerns its nature (rational, irrational, arational), appearances/qualia, degrees, dimensions and scales of conceptualization (internal, external, fractal, discrete, continuous, mechanical, quantum, local, global, etc.). Of particular interest have been parameters of time such as duration ranges, resolutions, modes (present, *now*, past, future), varieties of tenses (e.g. present perfect, present progressive, etc.) and some intuitive, but also fancy phenomenological characteristics such as "arrow", "stream", "texture", "width", "depth", "density", even "scent". Perhaps the most distinct characteristic of this fundamental concept is the *absolute time* constituting the *flow of consciousness* according to Husserl, the reflection of pure (human) nature without having the distinction between *exo* and *endo*. This essay is a personal reflection upon time in modern physics and phenomenological philosophy.



"I *now* predict that I was wrong."

Stephen Hawking (McCarten, 2013)

## 1. Prologue

Space and time are particularly modalities of human consciousness. Whereas space can be *real*ized through our eyes and limbs, time remains elusive to our minds and still bothers philosophers since antiquity (Dyke and Bardon, 2013). In the beginning of the 20th century science made a crucial switchover. Time was *spatialized*[1]. Until then the world was three-dimensional. With the Special Relativity Theory (Einstein, 1905; Minkowski, 1909) the concept of time became the fourth dimension[2] and an integral element of the new physical worldview. It caused confusion among many of Einstein's contemporaries, and not only with its relativistic dilation in the well-known equation with the speed of light $t' = t\,(1-(v/c)^2)^{½}$.

This notion of relativistic time appeared wrong and unnatural, not without good reason, since:

- Time is *ineffable* in its true nature, *eluding* science and mathematics: it can only be grasped through intuition and shown indirectly and partially through images (Bergson, 1912).
- Time is – concerning the extensities of the spatial – an *intensity*; it is a "qualitative, non-spatial, non-dimensional *inwardness*"[3] (Portmann, 1952).
- Time is a "heterogeneous dimension", which lies "transversely" to the "upright to it standing space dimensions"…. "The 4th dimension is a 'dimensio sui generis'. Accurately phrased, it is not a 'di-mension', i.e. a dividing measure, but an *a-mension*, i.e. an element free from division and measurement…. a basic phenomenon without spatial character. It is a *quality*, whereas

*E-mail address:* plamen.l.simeonov@gmail.com.

[1] It could be argued that time was spatialized earlier. Though time and space were separate for Newton (something that Einstein challenged), the clock time he assumed was laid out like space and was devoid of the dynamism of Bergsonian durée, (Bergson, 1912; Čapek, 1961).

[2] It was Laplace who treated time as just another dimension equivalent to space, and thereby paved the way for the development of relativity theory as it came to be understood (but not as Čapek, following Bergson, understood it).

[3] Die Zeit ist hinsichtlich der Extensitäten des Räumlichen eine Intensität, eine "qualitative, nichträumliche, nichtdimensionale Innerlichkeit". [translation from German and italics by the author].

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the measurability of the spatial dimensions lets them appear as quantities.[4]" (Gebser, 1962).

## 2. On time *with* time in physics: a personal perspective

In short, "time is not a categorical, and hence not a conceivable size[5]. It appears as an *acategorical* element, which cannot be registered systematically, i.e. spatially, but only *systatically*", i.e. when related to combination or synthesis (systatics)[6] (Gebser, 2011, p. 51ff).

Let us step back for a moment to realize a crucial moment in the history of physics preceding the development of both Special Relativity and Quantum Mechanics. This was the recognition of the limited frame of reference for physical laws, related to the fundamental issue of *time reversal* (T-symmetry) invariance and Loschmidt's Paradox, also known as the (ir)reversibility paradox. Newtonian mechanics, underlying low-level fundamental physical processes, is symmetric with respect to time reversal. "The equations of motion in abstract dynamics are perfectly reversible[7]; any solution of these equations remains valid when the time variable *t* is replaced by -*t*." (Thompson, 1874). However, the Second Law of Thermodynamics, describing the behavior of macroscopic systems, violates this principle. It determines a preferred direction of time's arrow by stating that the statistical state of entropy of the entire universe, taken as a closed isolated system, will always increase "over time" and never be negative. Loschmidt was provoked by Boltzmann's attempt to derive the Second Law from classical kinetic theory. He objected that it should not be possible to deduce an irreversible process from time-symmetric dynamics. Therefore, classical mechanics and statistical mechanics, both supported by a large body of evidence, were in conflict and hence the paradox. Today we know that certain physical forces (and laws) prevail at certain scales and become negligible at others; they may have evolved (Wheeler, 1983; Deutsch, 1986; Josephson, 2012) and cannot be derived from each other across the scales, at least to this moment[8]. We also know "now" that (physical) time is *asymmetric*, except for equilibrium states,[9] where time symmetry holds. Generally, past, present and future cannot be exchanged in physics according to the Second Law.

[4] Die Zeit ist eine "heterogene Dimension", die "quer" zu den "senkrecht auf ihr stehenden Raumdimensionen" liegt... "Die 4. Dimension ist eine 'Dimensio sui generis'. Sie ist exakt ausgedrückt, keine "Di-mension", also eine einteilende Maßgröße, sondern eine A-mension, also ein von Maβ und Messen befreites Element…. ein Grundphänomen, das kein Raumcharakter hat. Sie ist eine Qualität, während die Meβbarkeit der Raumdimensionen vornehmlich als Quantitäten erscheinen lässt. [translation from German and italics by the author].

[5] Time scales are *real*ized, i.e. experienced or felt as a *qualium* with no size at all (Salthe, 2013). Accordingly, time passing would be experienced at any scale 'the same', even though it is clear that when observing much larger or much smaller systems, they appear to be experiencing time more slowly or more rapidly than the observer's experience.

[6] "Sie – die Zeit – ist keine kategoriale und damit vorstellbare Größe. Sie erscheint als akategoriales Element, das nicht systematisch, also räumlich zu erfassen ist, sondern nur systatisch", d.h. in Bezug auf die Zusammenfügung der Teile zum Ganzen (Systase), "wahrnehmbar ist". [translation from German and italics by he author].

[7] However, motion itself is dissipative in the macroscopic case.

[8] The search for a General Unification Theory underlying all physical laws continues. Bohm's *hidden variables* (Bohm, 1952; Bohm, 1980) and Everett's *many-worlds interpretation* of quantum physics (Everett, 1957a, b; Everett, 1973) could still be instructive in this quest, not only for physicists – with a few exceptions they have been always claiming to address (replicable) phenomena in their research – but also for phenomenological philosophers.

[9] With possibly another "exception from the exception" for quantum noninvasive measurements which are supposed to violate time symmetry even in equilibrium (Bednorz et al., 2013).

The Special Relativity Theory brought essentially the *abolishment of simultaneity*[10]. Accordingly, it is impossible[11] to say in an *absolute* sense that two distinct events occur at the same time if those events are separated in space. Both Einstein and Poincaré came to the same conclusion explicitly referring to the concept of simultaneity (Einstein, 1905; Poincaré, 1898/1913). Before the arrival of Special Relativity space was considered a slice of reality cut by simultaneity, and (global) time required simultaneity to define valid relationships between objects in the universe. When simultaneity was abolished, both space and time were eliminated, at least in their classical meaning. If simultaneity is out, both space and time become meaningless as global parameters. Thus, physics rescued both concepts by assigning them local (relative) roles in a 4-dimensional space-time or time-space continuum. But in relativistic physics there are *no global space* and *no global*[12] *time* anymore. There is a *global space-time* (or *time-space*), which is locally manifested as space and time. Abandoning only one of these concepts does not make sense[13] according to Special Relativity. Where there is space, there is time. They go hand in hand.

In fact the statements "time (or space) exists" and "time (or space) doesn't exist" imply something of a linguistic paradox. I am going to discuss this in some detail here, because it makes explicit an interesting cognition about the topic of this essay. This is the appraisal that different disciplines often use or borrow from each other's definitions and ontologies with different context to conceptualize their perspective upon a subject. We experience in our everyday lives that most misunderstandings between scientists and philosophers, but also among scientists and philosophers within their own domains, are due to this problem. A more systematic approach to cross- and intra-cultural *multilogue* (Bateson, 1972) is required.

I shall come now to the point. Existence (E) or non-existence (~E) is one of the most fundamental forms of human *experience*. Relativity theory postulates the absolute *existence* of space-time (or time-space). This projects in an observer's coordinates to existing space and existing time. But for an observer space exists "en-bloc" as thing/object (Gebser, 1962), while *time exists as a process*, *durée* (Bergson, 1912). This is an important distinction. A physicist adopting this wrong premise can state that relativity theory, which makes space and time observer dependent, eliminates existence as a fundamental concept. S/he may claim that existence requires a predefined concept of time, implying a temporal logic with ope-rators such as 'before', 'after', 'always', 'never', 'eventually', 'sometimes', etc., in order to be applied within a postulate (suggestion or assumption of the existence, fact, or truth of something as a basis for reasoning). Mathematically it is not correct to describe spatial existence, temporal existence or the existence of a process (time) as one and the same thing[14]. In mathematics we have existence that is only logical and does not refer to either space or time. In the mathematical context we can discuss a process by adding a temporal operator or subscript,

[10] To claim this was the only way to reconcile with the constant speed of light in all inertial reference systems. Therefore it could be probably more correct to say that special relativity brought the *observer dependence*. [annotation by Felix T. Hong].

[11] In a way, the elimination of simultaneity by the Special Relativity is analogous to Heisenberg's uncertainty principle in Quantum Mechanics.

[12] The local concept of time was also discussed in earlier works of Salthe in connection with scale in the compositional hierarchy (Salthe, 1985; Salthe, 1993), where he discussed small-scale moments nested within large scale ones involving the idea of 'cogent moment' for each scale. The local concept of time becomes also interesting when looking at it within a multi-agent system, i.e. in terms of mutually referenced 'change' relationships in concurrent multi-agent systems.

[13] mathematically and because most physicists tend to take space as given/existent.

[14] [personal correspondence with Louis H. Kauffman, May 2015].