Review of: "Philosophical Aspects of Time in Modern Physics"

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Potential competing interests: No potential competing interests to declare.

Epistemology of time

Philosophy is the mother of all sciences, and when a modern science such as physics finds itself in times of trouble, struggling to rid the scientific view of the universe of the extant conceptual vagueness or theoretical indecisiveness, it turns to philosophy, just like grown-up people turn, in their dark hour, to their ageing parents, seeking helpful advice and hoping to hear words of wisdom. And because Aristotle was the father of philosophy, it is only natural to pay homage to him as one of the greatest thinkers of all time: as once observed by a colleague, “Everything was said by Aristotle”. Alfred Driessen’s article *Philosophical Aspects of Time in Modern Physics* is a good example of such homage, making up, at least to some extent, for what he characterizes as unawareness, on the part of scientists, of the philosophical discussions about the foundations of their science, the concept of time being such a foundation (along with the concept of three-dimensional space) of physics.

Driessen’s goal is to show that the stunning developments in 20th century physics, marked by the advent of general relativity and quantum mechanics, call for a revision of the concept of time that seemed to be well-understood and explained in classical physics, and even though it may sound paradoxical, the Aristotelian approach may “lead to a novel understanding of time in modern physics” (p. 1). But why should a physicist challenged with a specific problem turn to philosophy at all? Because, in most general terms, philosophy may be defined as the study of the fundamental nature of knowledge, reality, and existence, while physics is the science of matter, motion, and energy (Brown & Weidner 2024) as the fundamental constituents of reality. This poses the following questions, fundamental both for philosophy and physics: What is knowledge? What is reality? What is existence?

Literally, science is knowledge (from Lat. *scire* ‘know’), and we all know that “knowledge is power”. However, we have a very vague idea of what knowledge is or what it is to know (Kravchenko 2024). We know, thanks to F. Nietzsche, that “cognition comes through comparison”, and comparison implies the observability of the compared. Yet, as Driessen notes (p. 1-2), observables are a problem in general relativity (cf. Panagiotopoulos et al. 2023), and in quantum mechanics, Heisenberg's indeterminacy principle highlights the fundamental limits of the observer. This seeming weirdness motivates Driessen’s objective to try and solve the puzzle by putting the pieces together and getting a complete picture. In other words, he advocates for what seems to be a holistic approach summed up in the famous aphorism attributed to Aristotle: “The whole is greater than the sum of its parts”.

Driessen begins with Aristotle's approach to time, central to which is the notion of the continuum that can be static (any static material reality endowed with unity) or fluent, involving time in the case of movement and change, when a continuum extends in space and time. According to Driessen, "quitting the space dimensions altogether, one ends with a specific fluent continuum: time" (p. 4). This, however, is the first stumbling block in coping with the notion of time, because if there are no space dimensions in the observed universe, there is no movement or change (I leave aside the issue of why space is conceived of as having three dimensions and not, for example, two, cf. Scargill 2020). Moreover, as is clear from the quote from Aristotle's *Physica IV* given on the next page, Aristotle viewed time neither as movement nor independent of movement, and to know what time is, one had to discover what exactly it had to do with movement.

While we are more familiar with the metric structure of time, Driessen argues that Aristotle's definition of time ("number of motion in respect of 'before' and 'after'") relates to time's topological structure and what is known as the flow of time, or the arrow of time (p. 5). Hence the problem of the now as the essence of time in philosophy (Dunshirn 2006), because to Aristotle, who considered an analogy that involved the point on a line and the thing-in-motion, "the now and time are together, as are the thing-in-motion and its movement" (p. 6). Taking Aristotle's notion of the first mover as "the first of unmoved things, which being eternal will be the principle of motion to everything else" – he interprets Aristotle's view as follows: "the now remains the crucial relationship with time in the unmoved mover, and there is only a single now", not unlike a point on a line. However, there may be no topology outside of geometry as the study of space and the relationships between points, lines, curves, and surfaces. The latter are not real objects constitutive of the universe; they are abstract concepts[1] "grasped" by the words of a particular language (in this case, English), and as such, they are not independent of their names, just as time and the now, for Aristotle, are not independent of the thing-in-motion and its movement that are together. That is why, to Aristotle, the fluent continuum is a whole as part of reality that can be divided into parts only potentially, and until such a division has taken place, these parts are not objects of reality. This poses the question of what objects of reality are and whether they exist eternally or are the causal outcome of some process only hinted at by Aristotle when he speaks about the parts of a continuum being *in actu,* not being at all, and being *in potentia*.

To Driessen the physicist, "the change or movement is an object of reality"; therefore, time, as something intrinsically connected with movement, must also be an object of reality (cf. Hawking 1988). But what is reality, and how do we know that something exists[2] "out there" independent of what we, cognizers of this reality, think or say about it? Driessen's analysis and discussion of Aristotle's view of time is an analysis and discussion of certain aspects of reality as it is understood in modern science and objectivist (externalist) philosophy, centered on the concept of truth independent from the bias caused by one's perception, emotions, or imagination. On this view, reality is defined as "existence that is absolute, self-sufficient, or objective, and not subject to human decisions or conventions" (https://en.oxforddictionaries.com/definition/reality). As can be easily seen, objectivist philosophy can hardly be of help to modern physics that has rejected the notion of absolute time and the universe as a stage where things and events evolve. The question that arises in the context of Driessen's discussion is whether Aristotle was an external realist, for in that case, why turn to his philosophy looking for a clue to the puzzle of time in physics as an objective science? What feature of Aristotle's philosophical framework allows Driessen (2020) to view it as helpful in understanding fundamental aspects of quantum mechanics?

It is “a different line of reasoning”, in which (i) space, as a notion, does not belong to reality, only an object’s place does, (ii) there is no universal time, (iii) *now* is no part of time. Is, then, the universe constituted by the places as the boundaries of the things they contain, and how, in that case, does it agree with the general notion of the universe as all existing matter and space considered as a whole? Even if we do accept the idea of the universe as the sum total of all existing matter and space, leaving aside the question of existence itself, there is no room left for Aristotle’s maxim that the whole is greater than the sum of its parts. On the other hand, if we agree with Aristotle’s intuition, then we should look for that which makes the universe as a whole greater than its parts (matter and space) – that is, we should look for something that is not yet part of our knowledge of the universe as conceived by science. This takes us to the realm of epistemology and the fundamental question of the nature and function of cognition as a process and knowledge (*scientia*) as its “product”:

The basic claim of science is objectivity: it attempts, through the application of a well-defined methodology, to make statements about the universe. At the very root of this claim, however, lies its weakness: the *a priori* assumption that objective knowledge constitutes a description of that which is known. Such an assumption begs the questions, “What is it to know?” and “How do we know?” (Maturana 1970: 1)

These are the questions that philosophical externalism, with its rationalist epistemology, fails to answer in a coherent way, but without addressing this core epistemological issue, we cannot hope to come any closer to understanding time – or space, for that matter.

The problem with externalist epistemology is its intrinsic dualism, epitomized in Descartes’ famous*Cogito, ergo sum*, also known as the mind-body problem. As the faculty of consciousness and abstract thought, the mind enables humans to be aware of the world through experience and, therefore, to know, but what this faculty is remains largely a mystery to modern science. However, a new kind of epistemology has been gaining ground over the past several decades, in the framework of radical constructivism – a different school of thought as an alternative to the philosophy of external realism (Piaget 1970; Maturana 1970, 1978, 1988; Foerster 1972; Watzlawick 1984; Glasersfeld 1995). Maturana’s approach to cognition as the process of living, when “all doing is knowing and all knowing is doing” (Maturana & Varela 1987: 248), informs the two basic principles of radical constructivism (Glasersfeld 1988: 83):

1. Knowledge is not passively received either through the senses or by way of communication, but it is actively built up by the cognizing subject.
2. The function of cognition is adaptive and serves the subject’s organization of the experiential world, not the discovery of an objective ontological reality.

If we admit that human cognition is, qualitatively, radically different from animal cognition, then our attention should necessarily focus on the difference between how the experiential world of humans is organized as compared with the experiential world of non-human animals. This is where Max Müller’s (1961: 340) Rubicon metaphor readily comes to mind: “The one great barrier separating brute and man is Language. Man speaks, and no brute has ever uttered a word. Language is our Rubicon, and no brute will dare to cross it”.

Cognition serves the “subject’s organization of the experiential world”, hence an organism’s domain of lived experience is

its cognitive domain. As has been convincingly shown by Maturana (1970; 1978), the cognitive domain of humans is the domain of language, and human cognition is linguistic cognition (Kravchenko 2020). The relational domain of language as a self-constructed ecological niche of co-ordinations of coordinations of cooperative behavior is our "house of being" (Heidegger 1978) in which we "happen" as humans. However, because we cannot leave it and look at it from a distance (and the big is best seen from a distance), our "house of being" becomes an epistemological trap (Kravchenko 2016). Our attempts to cognize and describe the world we observe are constrained by what this trap affords; therefore, because language and the human brain co-evolved (Deacon 1997), the role of language in developing specifically human mental powers comes to the fore (Maturana, Mpodozis, Letelier 1995; Kravchenko 2021).

Counter to the established scientific view of the world as self-contained "objectivity", we live in a world constructed in language through what Maturana called "the fundamental operation of distinction", the specification of an entity operationally cleaved from a background:

[T]hat which results from an operation of distinction and can thus be distinguished, is a thing with the properties that the operation of distinction specifies, and which exists in the space that these properties establish. Reality, therefore, is the domain of things, and, in this sense, that which can be distinguished is real. Thus stated, there is no question about what reality is: It is a domain specified by the operations of the observer (Maturana 1978: 55).

Remarkably, this resonates with Aristotle's analysis of a continuum as a whole whose parts may be*in actu,* not be at all, and be *in potentia*: a continuum[3] exists as an object with the properties specified by the distinction made by the observer, and it is these properties that allow for the division of a continuum into the three existentially different types of parts *in the enlanguaged universe.*

Because both the world and the observer arise in language, they do not exist independent of each other but are one: "all that exists exists in language as consensual coordinations of consensual actions of observers, the observer included" (Maturana 1986: 3). Such an understanding of existence comes to the fore in Hans-Georg Gadamer's *Truth and Method* (2004: 440): "Language is not just one of man's possessions in the world; rather, on it depends the fact that man has a *world* at all. The world as world exists for man as for no other creature that is in the world. But this world is verbal in nature." Heinz von Foerster (2002: 71) was even more succinct in describing the world as an image of language: "Language comes First, and the world is a consequence of it". In other words, language is our existential universe, and science as "knowledge" is not a manner of revealing an independent reality as "objectivity without parentheses", it is a manner of bringing forth a particular reality bound to the conditions that constitute the observer as a human being, or "objectivity with parentheses":

Objectivity with parentheses entails accepting that existence is brought forth by the distinctions of the observer, that there are as many domains of existence as kinds of distinctions the observer performs: objectivity in parentheses entails the *multiversa*, entails that existence is constitutively dependent on the observer, and that there are as many domains of truths as domains of existence she or he brings forth in her or his distinctions (Maturana 1988: 11).

Therefore, "time" as a distinction made by the observer brings forth an object with the properties specified by this

distinction, and these properties may be different for different observers. In other words, the distinctions we make as observers affect theory adequacy (Kravchenko 2022) – something Einstein hinted at in his Heisenberg's 1926 lecture in Berlin: "Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed." Einstein's observation is fully applicable to the notion of time in physics as "objectivity without parentheses".

Driessen sees a connection between Aristotle's line of thinking and the consensus in modern physics that there is no universal time, and the now as the center of the theory of time is not really part of time. In physics, this inference is visually illustrated by the light-cone diagram (p. 9; see Hawking 1988, chapter 2), while Aristotle used the notion of the eternal "first mover" ("the first of unmoved things") as the principle of motion to everything else, thus accounting for the singularity of *now.* My suggestion is that this "eternal first mover" is nothing else but the observer moving through his life as a flow of lived experience (hence, the arrow of time)[4], and, phenomenologically, *now* is the ultimate point of reference for anything observed by the self-aware observer[5] who is the center of the enlanguaged universe as "objectivity with parentheses". Time is a mental construct grasped by a word when coordinating movements and their pace (Piaget 1970: 60).

The observer's lived experience is organized through a simple distinction between the current experience of that which is before the senses (present[6]) and that which is not (or past the senses). While our lived present (what is) is composed of the actually performed actions, our past (what was before) and future (what comes after) are constructed by reflexive action-thoughts in the cognitive domain of language. As argued by Simsky et al. (2021: 10), "the past is our memories of events that have led to the present as our current experience, whose predictable ability to change we call the future. The past and future as linguistic categories reflect the phenomenology of time, not its physical model: time does not exist outside humans". Time reflects, in linguistic semiosis, a certain kind of human-specific cognitive activity aimed at bringing order into the flux of experience as meaningful interactions with the world. Therefore, the construction of a temporal sequence that unites the present with the past and future in the arrow of time is possible only in linguistic semiosis.

Now, what makes the universe as a whole greater than its constitutive parts, matter and space-time? It is the realization that matter, space, and time are all objects that exist in "a domain specified by the operations of the observer". The domains of existence we call realities are established through evidence of a second observer: "Reality is that which can be witnessed: hence, rests on knowledge that can be shared, that is, "together-knowledge", or *con-scientia*" (Foerster 1966: 4). And "together-knowledge" comes through language as the cognitive domain of the observers in which reality is constructed as an infinite multitude of possible worlds. To use what I believe to be a more correct translation from Greek: "In the beginning was the Word, and the Word was **before** God (πρὸς τὸν θεόν), and the Word**was** God" (Bible, John 1:1). Understanding this solves the puzzle of time.

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[1] From Lat. *concipere* (from *com-* ‘together’ + *capere* ‘take’).

[2] From Lat. *exsistere* ‘come into being’ (from *ex-* ‘out’ + *sistere* ‘take a stand’).

[3] From Lat. *continere* ‘hang together’ (from *con-* ‘together with’ + *tenere* ‘hold’).

[4] Note that in Russian, for example, the word *время* ‘time’ is etymologically related to the Old Indian *vártma* ‘track, route, road’.

[5] This idea was explicated a century before Aristotle by Protagoras in his famous aphorism: “Of all things the measure is Man” (Speake 2015).

[6] From Lat. *præ-* ‘before’ + *sens* ‘feel’.