The Concept of Time in Husserlian Phenomenology and Quantum Physics

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ABSTRACT

Through a comparison between phenomenology and quantum physics, the paper aims to show that naturalising phenomenology can also mean bringing it into a critical and fruitful relationship with some of the most complex and fundamental questions of contemporary physics, thus showing both the truly ever-open potential of Husserlian and Heideggerian thinking and the need for the sciences to receive a theoretical light without which they risk remaining either magical, arbitrary and esoteric knowledge or technical, reductionist and epistemologically sterile.

To understand the temporality of consciousness it is essential to distinguish mathematical time from phenomenal time – as James, Bergson, Brentano and Husserl do. Brentano, notably, distinguishes two elements of consciousness: awareness of the perceived object and awareness of the way in which we are perceiving it, i.e., awareness *of the very fact* that it is a perception. The *perceived* is the primary object, the *event of perception* is the secondary object. It is also from here that Husserl begins his repeated and radical analysis of the *Phänomenologie des Inneren Zeitbewusstseins*.

Indeed, Husserl's phenomenology is a phenomenology of time. It is thought in action of living and experienced temporality. It is one of the most intense and fruitful efforts that philosophy has made since Augustine to understand time: its structure, its function, and the identity and difference that constitute it. Husserl's long and constant reflection on time has achieved fundamental results that are always open to new developments, investigations, and findings. However, one of the limitations of this reflection is its marked idealistic tendency, which often prevented Husserl from grasping the materic and objective

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dimension of time as well, which certainly dwells in a self-conscious part of matter – consciousness – but only because time also constitutes all that consciousness is not. Time of consciousness actually springs from the *bodilymental* unity of the living. This is also why it cannot be reduced to interiority.

Interiorisation runs through the history of philosophy since at least Plotinus and sees some fundamental stages in Augustine, Bergson and Husserl. These philosophers identified the origin of time in the interiority of the soul (spirit, consciousness). This also gave rise to the metaphor of the *flow* of time, already enunciated by Simplicio as well as by the Neo-Platonists. But it is evident that *if time springs from something*, that from which it springs cannot be a temporal phenomenon, on the risk of falling into a regress to infinity of which Husserl was aware but which he did not really manage to avoid and resolve.

The fact is that *time does not spring from anything* and it does not need to be constituted by something external to it - much less a human subjectivity - precisely because it is an original reality. Aristotle was also aware of this. For if, as the "number of movement", time would not be without an enumerating consciousness that is aware of succession, in any case time exists as the power of numerable movements even without ψυχή. Time is thus both in the *bodymind* and in matter. Time happens in their dynamics, in their movement, change, arising, becoming, decaying, ending. Time is this μεταβολή, it is the power of *becoming*, which certainly *determines all the motions of consciousness but does not need a consciousness that perceives it in order to be*.

I will try to show this complex dynamic, continuity and difference between the time of consciousness and the time of matter in phenomenology and quantum physics.

Phenomenological time and its problems

For Husserl, consciousness is literally made of time. In fact, the flow of time is also the flow of consciousness in itself. And it is also for this purpose, to clarify the status of consciousness, that Husserl's theoretical effort is always aimed at understanding conscious life as fundamentally temporal life.

Husserl identifies the understanding of time with the self-understanding of consciousness itself. The *original impression* (the now, the instant), the *retention* of what has just been, the *protention* towards what is to come, do not indicate just an objective present, past and future that is outside of us ('transcendent') but they are the relationships that constitute life, they shape meaning,

they are what makes the experience that we define with the terms of past, present and future meaningful. Original impression, retention and protention constitute *chronosemantics* as a horizon of understanding of being.

Time is not only "the most difficult of all phenomenological problems" (Husserl 1966, supplementary text no. 39) but is perhaps the most complex of all the many and varied topics in philosophy. By tackling it with its peculiar method, phenomenology shows its full nature, the theoretical power of its proceeding, and its limits. In fact, in Husserl's own definition, phenomenology is the "*science of pure consciousness*", which "*embraces in a certain sense all that it itself has carefully put out of play, embraces all knowledge, all sciences*" and the whole of nature, but it does so by suspending the obviousness of their giving themselves over to the naive gaze of everyday realism and philosophical realism and concentrating instead on the *intentionality* of the consciousness that knows, on the analysis of meaning, on the pure consciousness of phenomena – a consciousness that is not simply empirical or psychological – on the study of "what is thought, albeit not intuitively, as such, regardless of its reality or unreality" (*ivi*, supplementary text n. 51).

Time is the problem that tests the logical and empirical plausibility of phenomenological consciousness because time constitutes the world, its thinkability, and the consciousness that thinks it. Time weaves everything and seems to emerge from everything and yet, as Augustine already understood almost with dismay, "*si nemo a me quaerat, scio, si quaerenti esplicare selim, nescio*" (Augustine of Hippo 1998, XI, 14). The complex analysis carried out in Husserl's lectures is entirely under Augustine's sign, confirming the melancholic but exact thesis summarised by Husserl himself at the beginning of these lectures:

> in this matter, modern times, so proud of their knowledge, have not matched the effectiveness with which the seriousness of this great thinker attacked the problem, nor have they made any noteworthy progress (Husserl 1966, introduction, *my translation*).

Indeed, in Augustine, the non-empirical nature of time is already very clear. It is not an entity in the manner of chemical elements; it is not an aggregate of atoms, molecules, cells or other sets of elementary particles. Time, however, is not even merely the psychological perception of memory, expectation and inner duration, since: a) psychic consciousness is a natural object that falls fully within the scope of the empirical sciences, an object that is therefore transcendent and not

primary, constructed from the immanent data of phenomenological intentionality; b) the subjectivity of psychological consciousness cannot account for the universality of temporal phenomena. And thus

> the time that emerges here is neither objective nor objectively determinable. This time is not measurable and there is no clock or chronometer of any kind for it. Here one can only say: now, before and before again, changing or not changing in duration, etc. (ivi, supplementary text no. 51).

The most elementary observations of temporal experiences tell us that:

- there appears a flow of nows that follow one another incessantly; in this flow are contained both the entities that appear and their peculiar appearing for consciousness and therefore the first distinction to be made is that "between act and content, in particular between act, apprehensive content and apprehended object" (ivi, § 6). The apprehensive content is the immanent object that is first given to consciousness, the apprehended object is the secondary datum and therefore transcendent with respect to consciousness because it is constructed by it from the immanence of the first datum;
- everything that exists, by the very fact of its current existence, is destined to have been, to become past;
- the perceiving of consciousness is constituted by the intentionality with which it directs itself towards the now, by the presentification of the immanent datum, by the retention of the moments that have been, by the protention towards those that will be;
- retention represents the "fresh" (or primary) recollection of an immediate impression and from it the secondary recollection or remembrance is generated;
- remembrance is thus in its essence "consciousness of having-been-perceived" (ivi, § 27);
- the flow of presentified instants, of recollection and expectation always flows in the present of a consciousness: every recollection happens in the now (as awareness of the having-been), every expectation happens in the now (as awareness of the having-to-be), every perception happens in the now (as awareness of the perceived being). The now in which this conscious flow occurs is what we call consciousness;

- just as matter is made up of atoms, the flow of time is made up of such nows that we might call tempora or, more accurately, temp-ora; indeed, I believe it is useful to divide the ancient Latin word in such a way as to grasp temporality as an incessant flow of "nows";

- each of these temp-ora as it presents itself to consciousness then recedes from it and goes on to constitute the thick and deep reality of long-term memory, that memory which makes up the identity of each individual, his story, his most precious heritage;

- One of the ways in which Husserl expresses graphically these atoms of time that follow one another in constituting consciousness is as follows: 1) A, 2) A' B, 3) A' B' C, 4) A'' B'' C' D, 5) A'''' B''' C'' D' E , and so on" (ivi, supplementary text n. 24);

- living is this flow of temp-ora that shapes our body, gives it a history and with it an identity;

- this is why not only "time is the ineradicable form of individual realities" but - even more so - time is the mind itself and the mind is the indissoluble whole of consciousness, intentionality and body (ivi, supplementary text n. 39)[1].

It is possible, in this way, to begin to glimpse something of the enigma that consciousness has always been for philosophy. Consciousness is the cohesive whole - instant by instant - of the temp-ora that make up the flux of living, a simultaneous whole in its occurrence since in it coexist intentional experiences (the perception of the self, knowledge, information, feelings, emotions), external perceptions (sounds, smells, colours, flavours, shapes), memories (the whole constituted by retentions, remembrances, body memory), expectations (projects, desires, fears, worries, hopes), the primary certainty, and confirmed by the accumulation of *temp-ora*, of having to die.

If "awakened consciousness, awakened life, is a living going towards, a living that from the 'now', goes towards the new 'now'" (ivi, appendix 3) it is because consciousness is also corporeal and the senses that make up the body also constitute self-consciousness, open to the world, interwoven with finitude. Mind and body, therefore, are two aspects of the same temporal reality. One of the differences that make this profoundly unitary reality a dynamic one concerns

[1] Important, in this respect, are the insights into the rise of the temp-ora expressed through the intense metaphors and similes in the concluding pages of Proust's *Recherche*.

precisely the perception of time. The mind, in fact, forgets; it *must* forget in order to accumulate other *temp-ora*, to remain open to the future, to its protentions, to the expectations that give meaning to life. The body, on the other hand, not only does not need forgetting but grows through constant exchange with the flow of time in which it is immersed and in which it consists. That is why the body forgets nothing, it does not forget the exhilarating moments that have given it strength, it does not forget the suffering that others and itself have inflicted upon it. The accumulation of *temp-ora* of suffering - of which the existence of every entity is full - cannot be erased from the body and *that* is precisely why it dies. Mortality is rooted in time in a far more literal and physical way than is usually thought.

For phenomenology, time "belongs to all objects, it is not something we add to them, as if there existed for them an in-itself that was entirely without a relation to time. There is always a necessary relation to time [Die notwendige Beziehung zur Zeit ist immer da]" (Husserl 1999, § 64). If time belongs to every knowable entity and event, it also belongs to any possible knowing structure. Time as *form* is time as the original phenomenon from which everything takes its start, which entangles everything, which explains everything; time is the last and true absolute investigated in the *Ideen*, it is the *Zeitigung*, that temporisation which for Husserl constitutes the original happening as " *Verzeitigung der Verzeitigung*", "self-temporalization".

The unity of the *Zeitigung* is such that the present is always the consciousness of what has just been and has just happened, not the mechanical consciousness of an abstract, discrete instant, separated from the flow.

In the *Bernauer Manuskripte*, the structure appears even more radical since retention itself is awareness of the *protention that has happened*. Time is three and it is one, in the manner of the Trinitarian structure of Christianity and the dialectical structure of idealism. It seems that religions and philosophies are rooted in the dynamic of identity and difference that time is. Human consciousness is therefore time and conversely time is embodied in the human awareness of being. Everything that exists for us is experienced by us in the flux that accompanies it. In both its conscientialistic and worldly centrality, time is the very fabric of being; time is a continuously changing flux, filled with ever new contents. Flux that is also structure since, as Husserl recalls in the *Fifth Logical Investigation*, the contents of time in their mutation generate the temporal form that always remains constant precisely because it is form.

Quantum time and its problems

There is something dissonant if one of the greatest physicists of the 20th century (and Nobel Prize winner in 1965), Richard Feynman, declares that he can "safely say that nobody understands quantum mechanics" (Smolin 2019, p. xxvii). Whilst this reassures those who do not possess the mathematical and formal tools necessary to understand contemporary physics, it also shows a gnoseological checkmate that is disturbing. Even more so in view of the distance – an abyss – between quantum theory and the phenomenology of everyday experience.

The basic limitation of quantum mechanics is its radical anti-realism, as elaborated by the so-called Copenhagen interpretation, i.e., the research by Bohr, Heisenberg, Dirac, Pauli. These were countered by a different reading by the theory's initiator himself, i.e. Einstein, with whom de Broglie and Schrödinger agreed. Indeed, Einstein was an ontological realist who could not accept the mystical and certainly anthropocentric anti-realism of the interpretation developed in the 1920s and in fact dominant until the end of the 20th century (a discussion of Einstein's epistemology as a "novel blending of realism with a holist, underdeterminationist form of conventionalism" can be found in Howard, Don A. and Marco Giovanelli [2019]). Subsequently, the situation changed, albeit with obvious and strong resistance from the scientific-academic community that was oriented towards the dominant paradigm.

Quantum physicist Lee Smolin had the courage to rethink the question from the ground up. And he has done so starting from the observation that quantum theory is wrong in the sense that it is incomplete and therefore it is necessary to go beyond its limits. One merit of Smolin is that he never separates scientific analysis from the social context in which science happens. On the basis of his personal experience and against the backdrop of the philosophy of science of Popper, Kuhn and Feyerabend, Smolin reconstructs the history and describes the theory of a truly emblematic and enormously important event in contemporary culture.

At first it was Einstein, who clearly showed that light has a dual nature, being *both* a wave and a particle. However, he then always rejected the anti-realist consequences drawn from the dual structure of matter, such as those of Heisenberg and Bohr, who believed that quantum mechanics and any scientific theory cannot talk about what exists but must limit themselves to saying what is the result of human observation alone. For them, elementary particle physics only

deals with "observables" and not "beable", i.e. it does not deal with how atoms are actually made and their "objective" properties. Properties that quantum mechanics considers to be constitutively unknowable and *therefore* non-existent. As can be seen, the Kantian noumenal device and idealistic metaphysics in general is at work here.

Opposed to this are realist metaphysics and epistemologies - such as Einstein's and Smolin's - which hold instead that reality is autonomous from any observation; that entities, events and processes exist independently of any consciousness that perceives, observes or measures them. Science and philosophy constitute an attempt to understand these structures and not only to understand the *ways* in which a mind represents structures.

This ontological-epistemological knot is particularly intricate in quantum mechanics. Complexity that is also given by the fact that the turning point in it is the concept of field by which matter and energy are unified in a set of forces that do not operate *in* space and time but *are* space and time. Einstein's mathematical effort consisted mainly in working out equations that showed how the Riemann R_{ab} curvature of spacetime postulated by relativity is proportional to the energy of matter, so that the denser the matter, the more spacetime curves. Quantum mechanics also incorporated atoms and every possible particle into the field, so that the world would not be made up of *fields* and *particles* but of a single reality that is the covariant quantum field, whose fundamental characteristics are granularity, indeterminism and relationality.

Smolin shows the epistemological roots of these theses through two essential principles and rules.

The first can be expressed in this way: "We can only know half of what we would need to know if we wanted to completely control, or precisely predict, the future" (ivi, p. 14). From the very beginning, quantum mechanics is therefore incomplete, and it is incomplete by definition. Why does this happen? The answer lies in the two basic rules that guide such mechanics. The first, also called *Schrödinger's equation* or the principle of *unitarity*, states that "given the quantum state of an isolated system at one time, there is a law that will predict the precise quantum state of that system at any other time" (ivi, p. 27). A principle therefore firmly rooted in the scientific-philosophical tradition and clearly deterministic in character.

Instead, Rule No. 2 states a radical probabilistic modality, in the sense that the presence of an observer becomes decisive:

> The outcome of a measurement can only be predicted probabilistically. But

> afterward, the measurement changes the quantum state of the system being measured, by putting it in the state corresponding to the result of the measurement. This is called collapse of the wave function (ivi, p. 31).

The "collapse of the wave function" indicates a fundamental modality of quantum mechanics, which consists in postulating that, in a quantum system, the result of the measurement performed by an observer for some observable causes the observable to assume precisely the measured result, which without the presence of the observer/measurer would remain indeterminate (this is also the meaning of the notorious "Schrödinger's cat").

The paradoxes generated by such rules and principles are easily avoided if we consider that this theory is valid in the sphere of elementary particles, of the subatomic world, but no longer applies to macroscopic entities, to the world in which we are immersed, to the world that we ourselves are: cats, bicycles, humans, stars. A fundamental difference that is based on *decoherence*, i.e. on the

> process by means of which irreversible changes by averaging out the random chaos of the atomic real. Decoherence is a very important feature of quantum theory, for it is why the bulk properties of large-scale objects, such as the rough motions of soccer balls, swing bridges, rocket ships, planets, and so forth, appear to have well-defined values, which obey the laws of Newtonian physics (ivi, p. 128).

This is a central statement that must be thoroughly understood. For quantum physics, reality is dual. It is composed of both waves and particles. In the sense that *everything* is made up of waves and particles. And this is because, as Einstein discovered, energy is carried by light in discrete ensembles ('packets'), which he called *photons*. Light, however, consists of a collection of electromagnetic waves.

Einstein resolved the issue with the hypothesis that the energy of photons (the discrete component of light) is proportional to the frequency of the light wave that carries them. The hypothesis was much better articulated first by Louis de Broglie (1927) and then by David Bohm (1972), who elaborated the *pilot wave theory* for which matter is constituted and described in its entirety by the ensemble of waves and particles, since *the particle is guided by the wave*: "In its simplest formulation, two distinct entities are introduced: a material corpuscle that can be located and a wave that guides it, the wave function Ψ that appears in Schrödinger's equation. The wave has a direct physical meaning and should

be interpreted as an actual excitation of an underlying ether, i.e. the vacuum. It is provoked by the corpuscle but, at the same time, it 'drives' it in the sense that it determines its spatial momentum P through the relation $P = -h\nabla S$, where S is the phase of $\Psi = |\Psi|e^{iS}$" (Consoli, Pluchino 2015: 164, *my translation*). In this way, not only is the wave/particle dualism overcome, but the aether acquires the status of a hypothesis that is still very much present and very plausible within contemporary physics, a hypothesis rooted in the whole of science and metaphysics – not only European – and consistent with quantum mechanics.

The aether may constitute the ἄπειρον as the field/energy in which the *mattertime* flows, condenses, stands and happens. In general terms, the aether may represent absolute spacetime whose existence is by no means ruled out but on the contrary is implied by some of the most recent cosmological theories. The fact that quantum mechanics leads "to a vision of reality as a profoundly interconnected whole" (ivi, p. 52) confirms the significance and fruitfulness of archaic Greek thought, from which mathematics and physics arose and of which they remain heirs.

This is another reason why, in the opinion of many quantum physicists, the time has come to abandon the idealistic Copenhagen paradigm and to assume instead the more coherent realist paradigm, within which "it is very hard to justify giving a special role to measurements" (Smolin 2019, p. 55). This is in contrast with what Bohr and Heisenberg claim instead: for them sciences do not describe what exists but keep track of what is observable with instruments; they do not study nature but deal with the way humans know the supposed nature from the *instruments* they use to investigate it. This is, as we can see, a radical and idealistic form of *instrumentalism*.

For physical-ontological realism, the wave function is an aspect of reality and not just the human way of measuring it; the quantum state is physically real, not a numerical representation that exists only in the human mind. Without the realistic assumption, physics and the other sciences risk moving away from their own object of investigation, which is first of all the world and only subsequently the human way of understanding it. This is shown by a plethora of hypotheses and theories, from Everett's tendentially realistic one to the more recent string theories, multiverse theories and relativity itself in many of the interpretations that have been given. These theories are dangerously close to an irrationalism that is the other name for mathematical formalism when one confuses a tool, however wonderful as mathematics is, with the material density of the

world, of entities, of events, of processes. An irrationalism that says it is convinced of the existence of an infinite number of copies of every entity, including every human being; it says it is convinced that the innumerable set of possible events all exist somewhere. We, I who am writing and you who are reading, would in turn be one of many copies. Reality dissolves and physics becomes "una rama de la literatura fantástica" (J. L. Borges, *Tlön, Uqbar, Orbis tertius*).

Smolin and other contemporary physicists oppose all this with simple and formally elegant hypotheses/theories based on the real existence of events, causality, irreversibility, energy and, above all, time, which does not exist before events but coincides with events, which occur along an irreversible line from the causal past to the causal future of each entity, in an incessant transmission of energy, momentum and information. Energy that is therefore always conserved and always changes, consistently with the first two principles of thermodynamics.

> Time, in the sense of the continual becoming of the present moment, is fundamental to nature. Indeed, our experience of time's passage is the one thing we directly perceive about the world which is truly fundamental. All the rest, including the impression that there are unchanging laws, is approximate and emergent. (Smolin 2019, p. 217).

The theory of temporal relationalism holds that time is fundamental and irreversible, and that space understood as the present emerges from it.

> *Time, in the sense of causation, is fundamental*. This means the process by which future events are produced from present events, called causation, is fundamental.
> *Time is irreversible*. The process by which future events are created from present events can't go backward. Once an event has happened, it can't be made to unhappen.
> *Space is emergent*. There is no space, fundamentally. There are events and they cause other events, so there are causal relations. These events make up a network of relationships. Space arises as a coarse-grained and approximate description of the network of relationships between events (*ivi*, pp. 193-194).

A radical consequence of temporal relationalism as opposed to the eternalist relationalism of Parmenides and Einstein is that "There may be a fundamental simultaneity. At a deeper level, in which space disappears but time persists, a universal meaning can be given to the concept of *now*" (*ivi*, p. 194), thus resolving many of the paradoxes and ambiguities of invariance/relativity theory.

Phenomenology and its solutions

Time is the fundamental question of phenomenology. This is also demonstrated by Husserl's constant return to the topic of temporal constitution. The *Zeitvorlesungen* date from the years 1893-1917, the *Bernauer Manuskripte* from 1917-1918, the *C-Manuskripte* from 1929-1934, thus touching on the entire span of Husserlian reflection. The 17 manuscripts of the C group preserved in Leuven possess at least four characteristics that make them theoretically fundamental and historiographically very intriguing.

The first is constituted by the centrality of the *lebendige Gegenwart*, of the living present in which the entire temporal is contracted and regrouped. "Ohne sie [lebendige Gegenwart] hat nichts überhaupt Sein"', "without the living present nothing exists at all" since "meine strömend-lebendige Gegenwart, die urmodale, trägt alles Erdenkliche in sich; sie ist die urzeitliche, überzeitliche, 'Zeitlichkeit', die alle Zeit als verharrend-seiende Zeitordnung und Zeitfülle in sich trägt", "the flow of my living-present, the original mode, carries everything imaginable in itself; it is the originally temporal, supratemporal 'temporality', which carries all time in itself as a temporal order that happens by remaining as temporal fullness" (Husserl 2006, C2, text 7, *my translation*).

The constitutive elements of the living present are "Hyle, Akt, Intentionalität, Gegenwärtingung und Vergegenwärtigung", "materiality, act, intentionality, presentification and remembrance" (*ivi*, C2, T. 17). This structure contributes to making the living present the key element of the original flux that constitutes "das Urphänomen aller Phänomene", "the original phenomenon of all possible phenomena", a true "Heraklitische Fluss", "Heraclitean flux" that gives form to consciousness (*ivi*, C2, T. 1); "Alles und jedes ist Einheit im Strömen", "everything and the whole are in fact unity in flux" (*ivi*, C2, T. 1).

If time is the original absolute, how does it unfold and manifest itself? Time is also the dynamic between the instant as *Urimpression*, original impression, and becoming as the flux of all impressions and instants. The node of this dynamic is the *now*, the *present*, which is never isolated and static but is always part of a whole composed of intentionality towards what is happening, retention of what has just happened, and protention towards what is about to happen. Elements that are not to be understood as separated but always in the profound unity that constitutes them.

Consciousness consists precisely in the unity of this structure and the awareness of its parts. One goes from protention to its filling in the present,

which immediately becomes retention of what has just happened. And then it begins again at each instant, ad infinitum, as long as consciousness is awake, as long as the body is alive. To look for a *beginning* in all this is to fall into an attitude that is both banally naturalistic and completely abstract. Just as there is no beginning to matter, so there is no beginning to temporalisation. Unless we refer to the very awakening of consciousness in the body.

That is the gnoseological beginning, based in turn on the ontological incipit of the σῶμα. Before flow there is always flow, before time there is always time.

Flow, *Strömen* can take on three aspects, have three meanings. *Strömen* is pre-temporalising living flux (*vor-zeitigend*); *Strömen* is flux of experiences immanent to consciousness (*Erlebnisse*); *Strömen* is the time of the world (*Weltzeit*), the becoming of all things. The totality of these flux structures is the *Zeitigung*, the temporisation not of consciousness and the world but of the consciousness-world, of the consciousness that is the part of the world that understands itself, that experiences time and experiences itself as time.

Being also time in act, consciousness shares the dual character of flowing and remaining, of transiting and remaining, of difference and identity. Flowing is the unalterable form – *beständige Form* –, which contains time as χρόνος and as αἰών, as invariant form and as content that is new each time.

The present is thus the future that has just been. Consciousness is the structure that maintains in itself the future that has become past. This is its constant present, its immobility made of flux, its identity constituted by difference. It is the retention-now that makes possible the remembrance of the past, which insofar as it is remembered-now is also present. The future is the protention of this retention-now of the just-before in the immediately advenient instant. The difference between the present-instant and its retention-now is the origin of time-consciousness, the origin of the self-knowledge of consciousness *as* time.

Human consciousness is therefore time, and conversely time is embodied in the human awareness of being: "Alles für mich Seiende ist für mich erfahren und erfahrbar in dem ihm zugehörigen Strömen", "everything that exists for me is experienced by me and experienced in the flow that accompanies it" and "die Welt - allzeitliche Welt - ist ohne mich nicht denkbar", "the world - the world full of time - is unthinkable without me" (*ivi*, C2, T. 1, p. 3; C17, T. 97). Even from such a profound correspondence between consciousness and time, the *C-Manuskripte* deals more directly than other Husserlian texts with issues such as sleep, being born, dying, coming to the conclusion that "Geburt und

Tod, die zunächst empirisch angesehene Grenzen des Könnens ausdrücken, aber offenbar über das Empirische hinaus Bedeutung haben möchten", "birth and death, which at first express a limitation of fact, possess meanings that go beyond any empiria" (*ivi*, C7, T. 28) .

It can be said, and this is a second element of great interest of the *C-Manuskripte*, that in its both conscientialist and worldly centrality, time is the very fabric of being. A thesis, as we can see, that is both ontological and metaphysical. The world, in fact, "im Strom der Zeitmodalitäten ist eine Welt identisch 'verharrenden' Seins, realer Substanzen, verharrenden in den Veräbderungen des Seienden", "in the flux of temporal modes is a world identical to being 'which persists', made of real substances, which in the transformation of entities persists" (*ivi*, C3, T. 15). The world is the *difference* of its temporal moments and is the *identity* of the flux in which the individual moments acquire meaning and fullness. Becoming consists in an *Urverschmelzung*, a fusion of original impression and change that preserves that which changes.

We are very close to what in *Sein und Zeit* is time as *gewesend-gegenwärtigende Zukunft*, future-having been-presenting (Heidegger 1996, § 65). This original phenomenon of being and knowing is the living and flowing present, *lebendig* and *strömend*, it is plural and becoming time, it is the static and dynamic now. *Nunc stans* is the now that stands and abides. *Nunc fluens* is the happening of events that from time to time are the now. *Nunc aeternitatis* and *Nunc temporis* are different but not opposed to each other. Eternity is in fact the whole that springs from the endless power of becoming. The αἰών is matter here and now, thought all at once, the χρόνος is such matter in the form of a stasisless energy that expresses itself in an innumerable multiplicity of modes and forms. Time is thus the original phenomenon insofar as it is both flow and structure.

It is therefore not far-fetched to liken the analyses formulated in the *C-Manuskripte* to some of the existential ones in *Being and Time*. And one can do so starting precisely from the identification of being and time: "Welt ist zeitlich seiend, sie ist selbst nichts anderes als erfüllte Zeit - Weltzeit, Raumzeit", "the world is a temporal structure, it is nothing but time in its fullness - the time of the world, space-time" (Husserl, 2006 C7, Text 28).

In an unusual and beautiful way, these Husserlian manuscripts close on a cosmic tone:

> Ich in strömender Lebensgegenwart, Quelle der für mich geltenden Welt, Quelle auch der Idee der Wahrheit und der Wissenschaft als Vorhabe und der

> für mich seienden Anderen etc. - 'Quelle'.
> Das Absolute, verharrend in Ewigkeit im ewigen Wandel seiner Modi, zunächst durch gewöhnliche Geburt der Tod -aber auch Geburt und Tod von Menschheit etc.;
> Identität der Strukturform (invariante), die Form der absoluten Zeitlichkeit, die Form der absoluten Koexistenz, deren Symbol der Raum ist; aber auch die räumliche Verteilung der getrennten, entstehender und sterbender Gestirmenschheiten und Generationssysteme von 'animalischen' Spezies; Gestirn, Milchstraßensysteme.
> "me in the living present, in its flow, the origin for me of the sense of the world, the origin also of the idea of truth and science as understanding and source of the existence of the Other etc. - 'Source'. The Absolute, which remains constant in the eternity of its ever-changing modes, first and foremost through the common birth and death - but also in the birth and death of humanity etc;
> Identity of structure (invariant), the form of absolute temporality, the form of absolute coexistence, the symbol of which is space; but also the distribution in space of human action that separates, that generates and that dissolves, and the universal manner in which animal species are generated; stars, galaxies (*ivi*, C17, T. 97).

All this happens in the now, in the now retained, in the now to come. Structures that constitute the same reality that is and that becomes, constitute the identity and the difference that time is.

Quantum physics and its solutions

The Husserlian solutions we have just seen find confirmation in certain developments in contemporary physics that go beyond the prejudice of the unreality of time. Indeed, the belief of many contemporary physicists that time is unreal constitutes a form of mathematical Platonism that has, however, abandoned the deep connection Plato feels with reality as a whole and as a problem, replacing this ontological seriousness with the simple allure of mathematical elegance and formalism, which, however, in no way guarantee the truth of their assertions but only the need to eternalise themselves.

It is therefore much more valid for the present sciences than for Plato that "there's a cheapness at the core of any claim that our universe is ultimately explained by another, more perfect world standing apart from everything we perceive. If we succumb to that claim, we render the boundary between science and mysticism porous." (Smolin 2013, p. 11).

The theory of relativity and quantum mechanics are opposites but share the Newtonian primacy of mathematics. Physicists practising this paradigm behave like laboratory zoologists, who study animals confined in totally artificial conditions, reducing their behaviour to pre-established, abstract patterns. Just as ethology liberates animals by studying them in the concreteness of their environments, so the paradigm of the reality of time liberates the complexity of becoming from its reduction to equations.

It is also a similar difference to that between a football match, a goal for example that happens in time once and is unrepeatable, and the *recording* of that match, repeatable as many times as one wants, which has somehow become timeless. Becoming does not coincide with the ways in which it is recorded, because becoming is a boundless and complex set of relationships. Instead, it has happened that from the three-body problem to supercomputer simulations, "stars consisting of vast numbers of atoms are treated as if they were points, and the influence of anything outside the system is usually ignored" (*ivi*, p. 46).

One of the costs of the success of efficient theories lies in the fact that what appear plausible are approximations that cannot, however, be made to coincide with the structure and complexity of matter and nature. The fact, for example, "the motion takes place in time whereas its mathematical representation is timeless means they aren't the same thing" (*ivi*, p. 36).

Movement, becoming, possibilities, phenomena, matter, the universe, constitute the immense and complex being that unfolds in every recess of time and space. From the basic principles of both Newtonian and Einsteinian physics, such complexity is improbable. Yet it is there and it happens. It is this reality that must be explained. Because the transition from the simple to the complex is not found in equations, it is not predicted by the operation of timeless structures.

"Doing physics in a box" means exchanging the part for the whole, the laboratory for nature, the abstraction of an isolated fact for the concreteness of relations within which only every entity, every event and every process can occur - ontology - and can be explained - epistemology.

Like other physicists, Smolin started out from the thesis of the unreality of time, but he had to courageously change his mind, to the point of supporting a temporal ontology for which time is "the key to the meaning of quantum theory and its eventual unification with space, time, gravity and cosmology" (ivi, pp. XII and VIII); adopting a falsificationist methodology that considers as scientific

only that which produces predictions that can be falsified; arriving at a courageous temporal conception even of scientific laws, removed from Platonic structures beyond concrete, experiential, phenomenal time and space.

In this way, a metaphysically realistic perspective unfolds for which "time and its passage are fundamental and real and the hopes and beliefs about timeless truths and timeless realms are mythology. Embracing time means believing that reality consists only of what's real in each moment of time" (*ivi*, p. X) and consists of its unstoppable, directional, continuous motion.

The block-universe of Einsteinian invariance theory, the atemporal nihilism of Emanuele Severino, Julian Barbour's vision of discrete moments that all remain eternal and for whom "the only true things are complete possible configurations of the universe, unchanging Nows. Unchanging things do not travel in time from Now to Now. Material things, we included, are simply parts of Nows" (Barbour 1999: 49), the consolation such theories offer to mortality and finitude, are all forms of eternalism that are well known in the metaphysical tradition and find their most powerful expression in Parmenidean ontology, to which Smolin contrasts a Heraclitean physics and an ontology in which Anaximander's thesis about the generation of every entity from other entities and its dissolution in other entities, κατὰ τὸ χρεὼν [...] κατὰ τὴν τοῦ χρόνου τάξιν, in a necessary way, according to the order, the structure, the measure of time.

The Anaximandrean and Heraclitean foundation of these new quantum hypotheses has as its fundamental junction the Leibnizian principles of sufficient reason and the identity of the indiscernibles.
Indeed,

> If time is real, it should be impossible to have two different but identical moments of time. Time is fully real only in a Leibnizian universe. A Leibnizian universe will be full of complexity that generates a bountiful array of unique patterns and structures. And it will be ever changing, to ensure that every moment can be distinguished from every other by the structures and patterns present then. As indeed is our universe (Smolin 2013, pp. 216–217)

Time is thus confirmed as the most important theme and problem of physics and of all the sciences that do not wish to assume a mystical-mathematical dimension and language. "The hypothesis of the reality of time leads to a more scientific cosmology" (ivi, p. 248), because it leads to a cosmology that no longer needs the physical, religious and ethical attempts to console us of the nothingness in

which every entity is destined to dissolve as an entity in this form here, in this determinate mineral, vegetable, animal, atomic and cosmic structure.

Naturalising phenomenology, theoreticizing physics

Far from "not existing", time is thus the very existence of every entity, event and process, precisely in the quantum sense that there are no *objects* unrelated to each other but only *events* linked to each other in an indissoluble way.

> The world of quantum mechanics is not a world of objects: it is a world of events. Things are built by the happening of elementary events. As the philosopher Nelson Goodman wrote in the 1950s, with a beautiful phrase: 'An object is a monotonous process' [...] We, like waves and like all objects, are a flux of events; we are processes, for a brief time monotonous... Quantum mechanics does not describe objects: it describes processes and events that are junction points between processes (Rovelli 2017a, p. 135-136)

Time is said in many ways: physical, thermodynamic, psychological, mechanical, social, conventional, existential. And humans are one of the temporal forms in which matter is structured.

And therefore

> one can think of the world as consisting of *things*. Of *substance*. Of *entities*. Of something that *is*. *That persists*. Or think of the world as consisting of *events*. Of *happenings*. Of *processes*. Of something that *happens*. Which does not last, which is continually transforming. That does not persist in time. The destruction of the notion of time in fundamental physics is the collapse of the first of these two perspectives, not the second. It is the realisation of the ubiquity of impermanence, not of the static nature of motionless time (Rovelli 2017b, p. 87, *my translation*).

Well before the 20th century and its quantum and relativistic investigations, this was the perspective of much philosophy, starting with Anaximander and Heraclitus: "The world is not a collection of things, it is a collection of events" (*ibidem*).

The distinction between the now that is and the now that becomes is the deepest core of ontological difference: "*Daß das Seiende ist aufgrund des Seins, daß aber das Sein selbst nicht ein Seiendes ist. Sein und seiendes sind unterschieden* - dieser Unterschied ist der ursprünglichste, der überhaupt sich auftun kann. Also Ergebnis: das Sein ist nicht das Seiende", "*The entity is on the basis of being, but being itself is not an entity. Being and entity are different* - this

difference is the *most original* difference that can be made. The result is therefore: being is not entity" (Heidegger 1989, Band 35, § 6, *my translation*).

The now that stands are the entities. The now that becomes is being, its difference, its friction, its transparency. The now that is is real, the now that becomes is real. Entities are real, being is real. The being of time is its becoming; ontological difference is the temporisation of being.

This means that "*der Unterschied von Sein und Seienden ist in der Zeitigung der Zeitlichkeit gezeitigt*", "*the difference between being and entities consists in the temporisation of being that entities are*" (Heidegger 2012, Band 24, § 22, *my translation*). Being becomes and is, entities are and become. This, too, is time. The understanding of this dynamic of being/entity is temporality. The comprehending *bodymind* is inseparable from being as time. It is the same structure, it is the same time that in the human becomes *bodymind* and in matter is being.

Naturalising phenomenology can also mean bringing it into a critical and fruitful relationship with some of the most complex and fundamental questions of contemporary physics, thus showing both the truly ever-open potential of Husserlian and Heideggerian thinking and the need for the sciences to receive a theoretical light without which they risk remaining either magical, arbitrary and esoteric knowledge or technical, reductionist and epistemologically sterile. In the genetic code of Husserl's philosophy lies a rigorous, constant and asymptotic (i.e. never definitive and always open) confrontation with mathematics and physics, which today also means helping to bring quantum theory closer to phenomenal reality, to the world of life.

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