



Why is Time Frame-dependent in Relativity? Minkowski's spacetime as a Kantian 'condition of possibility' for relativistic calculations

Mariela Szirko

Neurobiology Research Center, Ministry of Health, Argentine Republic,
and Laboratory of Electroneurobiological Research, Neuropsychiatric Hospital "Dr. José Tiburcio Borda"
Government of the Autonomous City of Buenos Aires
Ave. Amancio Alcorta 1602, Buenos Aires 1283, Argentina
E-mail: Mszirko [-at-] Sion.com

Abstract

The kinematic consequences of special relativity can be expressed in three-dimensional language. Remarkably, this does not mean that, for making special relativity operational, positing a three-dimensional ontology is as good as positing the four-dimensional ontology. This is a singular limitation, whose nature is worth close inspection. In exploring it not just within a traditional, kinematic or geometric perspective but in its modern scientific context – *i.e.* as regards (1) causation, (2) localized observers that physics finds in nature and are not mere short forms for reference frames, and (3) the semiosis they develop and use to make reference to distant present objects – this essay pursues two aims. First, to put on view that the block universe outlook, regarding the macroscopic-scale universe as a timelessly existing four-dimensional world each of whose diverse items is composed of temporal parts, despite its being ontologically incorrect is indeed the only one that is consistent with special relativity, whose calculations are correct. This is tantamount to point out that the special relativity's descriptions of the macrouniverse necessitate to portray time as a dimension, and moreover as an uncollapsed one; *i.e.*, as a compass wherein mobility, in the vein of the translocative motion that may occur on every spatial dimension, ought to be at least conceivable. Second, to probe arguments defending that special relativity alone can resolve the debate on whether the extramental macroworld is three-dimensional or four-dimensional. In particular, since relativity's condition of possibility, namely the imposition on relativistic observers of describing at once past, present, and future states along the length of the observed moving entities, has been considered a proof that past and future components of real entities enjoy an unremitting mode of existence, the main argument probed in this paper is the one claiming that "if the world were three-dimensional, the kinematic consequences of special relativity and more importantly the experiments confirming them would be impossible." This is acknowledged as exact but it is remarked that, such imposition being a Kantian condition of possibility, it cannot reveal anything about what Kant called noumenon, *i.e.* extramentality.

The present essay originated as scholia to Ref. 1 (Petkov; see "Acknowledgements"), whose structure it thus closely follows.

1 Introduction

1.1. Struggling against time. Explicit or implicit presentism, the view that only the present (the three-dimensional world at the instant 'now') exists, is the standard view on reality. Some research in history of ideas [2; 3, pp. 567-823, 963-4] concluded that presentism is generally disowned only in some human groups where inner coercion is specially important and thus appreciated, such as very stratified social organizations instanced in rigorist settings as much diverse as certain pre-Columbian Mesoamerican cultures, the shoguns' Japan, and academic societies devoted to logic, mathematics, or theoretical physics. Those rigorisms go along with a societal need of looking for exemptions to waiting [*e.g.*, for getting commands done, or for measuring frequency: 3, p. 312] and of denying reality to the irreversibility of time elapsing, whence efficient extramental causation becomes denied and imaginarily substituted by relations among subjective, mental contents; these contents, when generalized, are often understood as Platonic Ideas, connected not by way of efficient causality but by their inner buildups or idiosyncratic, essential 'virtues'. In the thus built reality, no 'present' state of affairs is privileged with the exclusive possession of powers to metamorphose itself into other states of affairs. Rather, it is claimed, every situated observer's experience crawls upward along its worldline collecting sensory information, but incorrectly interprets this information as meaning that *only* a constantly changing reality exists – whereas, in fact, past and future states are ontologically analogous to the present ones.

1.2. Observation matters. Yet, which scientific observation would lend any support to rigorisms? Where on earth one could witness past and future affairs? A failure of simultaneity might be of use so long as, in becoming simultaneous, the entities leaving themselves to be known as arriving from other times retain a label revealing their formative epoch. Special relativity foresees that if a not-pointlike but extended entity is described by some eyewitness placed on an inertial frame of reference in relativistic motion, each distinguishable segment of the lengthy entity, consecutively positioned along the direction of relative motion, is to be described at a different present. So, as rigorisms wish, simultaneity seems to break down: some of those 'presents' did already occur (stay past) and others not yet occurred (remain future) in an inner or proper-time perspective taken by an observer located at rest in the very entity's middle segment; such a segment in the instant of the description is locatable, after some calculations on the signals' speed, the nearest to the relativistic eyewitness. This darting eyewitness, in turn, must remotely describe this mid segment of the extended entity (often visualized as a train of wagons, or as a rod pointing to the motion's direction) as it was in the past time which lags behind the outer eyewitness' present exactly by the shortest delay among all the signals coming from the segments of the lengthy entity – but nevertheless the entity's segments, which harbor events described as past and future in the inner, local, rest, or proper-time perspective taken from the middle segment, should *also* be described by the outer eyewitness as in the present scenario. In this way they are simultaneous for the outer, remote, relativistic eyewitness and sequential for the inner, local, resting observer.

Whence splitting the subuniverse and shifting the halves past another at relativistic speeds should suffice to grace with one's presence both bygone cosmogenesis and remotely impending cosmoclastics. This cannot help but make up an exciting prospect, whose academic entertainment depends on neglecting the same calculations for all the signals coming from the segments of the lengthy entity. The point is discussed below, though anyone seeking an exception to waiting might find explanative the outline in footnote¹; key to give good reason for such sequences' simultaneizing is that, most remarkably, it only occurs inasmuch as the not-pointlike, extended entity shares in the direction of the frames' motion. The entity, though often pictured tilted at a certain angle, ought to spread itself over a small piece of its path.

But the issue at stake is far more interesting than estimating Doppler effects on the Pythagorean theorem for a space that keeps the signals' travel null from their own frame of reference while making that, from all the other inertial reference frames (only the local ones, in general relativity), such a null travel be seen to span some distances at speed c . The said neglect of the mentioned calculations depends on paying no heed to the very building of the developmentally-acquired hermeneutical ability to make sense of the physical semiosis involved in perceiving

¹ This simultaneizing optical illusion comes from Pythagorean-theorem constraints on the distribution of light-speed signals that undergo Doppler distortion after their having been sequentially emitted at different segments of the lengthy entity. At the meeting instant, when the extended entity's middle segment is the one which stands the closest to the outer eyewitness, some past event at the entity's rear has been already signaled, some time before, by a photon emitted there. This photon has been traveling some distance while the outer eyewitness fled ahead of it in the same direction with a speed not very different from that of the photon. This redshifted first photon thus arrives to the relativistic eyewitness a bit after the meeting instant; namely, at the same instant that another, differently redshifted photon from the lengthy entity also arrives to the eyewitness, the second photon having been emitted from the entity's middle segment some time after the previous one. Still later in the frame of reference of the lengthy entity, a third photon has been emitted from the entity's front segment, but the latest photon traveled to encounter the relativistic eyewitness which was coming onto it from the opposite direction (or at a certain angle) so that the third photon arrives redshifted in another way or even blueshifted, yet – also – a bit after meeting time: too in the precise instant that the two previously emitted photons arrive. So the three photons become present (literally and physically) to cause local effects at the relativistic eyewitness in the same instant; *i.e.* they are genuinely simultaneous in the outer eyewitness' frame of reference, whereas they have been non-simultaneously emitted at different segments of the lengthy entity and, afterward since, they traveled at exactly the same speed, on different spacetime paths. The 'transframing' stays smooth in both its backward and forward logs, the account being the same one that specifies for the so-called twin 'paradox' which brother is in fact younger at their re-encounter. Some summaries of the many detailed calculations are pointed out in the legend to Figure 6. Neither the twin 'paradox' appears nowadays paradoxical nor this simultaneizing achieves effects from non-present physical causes. (Other simultaneizings, by altering the observer's time resolution, rather merge extramental sequences into molarly-acting situations, but this class of occurrences [6] is completely unrelated.) Paying no attention here to other obvious constraints, it might still behoove us to remark that this simultaneizing optical illusion, because reference frames cannot arrive to move one past another with any $v \geq c$, stands restricted to such lengths of the lengthy entity that can be accommodated by lightcones. Therefore, even if one is prepared to observe nothing (as neither the redshifted nor the blueshifted photons could longer inform, *e.g.* transfer energy to, any other thing), one not either could split the $\sim 140^9$ light-years wide subuniverse (its age is only $\sim 14^9$ years, but if the speed of light indeed was not varying we seem bound to assume that for some period our subuniverse expanded, or space was being created, superluminally) and then grace with one's presence both its big bang and eventual big crunch by relativistically swifting the halves – because of the subuniverse's length is excessive thereto.

distant events. On certain historical reasons, introducing intellectual development into geometrical physics might appear irritating. Yet, since relativistic calculations relate to items in motion, a semiosis-installing *distance* from those events is indispensable in order to show that observers need not agree on which events are simultaneous. (For exhibiting this dependence on the state of motion of the observers, such observers ought to stand in relative motion, which must be translative; it precludes showing this relativity by analyzing the simultaneity of the not-spatially-distant mental contents in a single-observer, or – everything else unmodified – the perspectives of different observers occupying the same spacetime point one after another). Here it may be advanced that the mentioned developmental building of the ability to perceive distant events as distant involves frame-invariant causation – but this involvement is a matter of genetic epistemology, an academic department whose relationships with the one of relativity physics have much been overlooked, if at all minded. Still as a further, ultimate basis for mystification, the 'exciting prospect' rests on taking 'to be' as if it only were an intrinsic aptitude to properly accept combinable predications, rather than recognizing 'to be' as an unexpressible, non-conceptualizable enactment cancelling nonexistence; this slip-up, moreover, is one entrenched in social roots. A real stack of misinterpretations, truly. Deconstructing all of it, even sketchily, will take the remaining of this transdisciplinary article. Pending such a deconstruction, the imposition on relativistic observers of describing at once past, present, and future states along the length of the observed entities has been considered evidence that past and future components of real entities enjoy a unremitting mode of existence, authenticating the rigorist denial of presentism.

1.3. Distinguishing subjective and extramental denotations. In utter contrast to such rigorisms, the presentist common-sense view reflects the way most people – and probably other primates and birds [4] as well as reptiles [5] – perceive the world. But in order to deal with world perceptions we need to clearly tell apart the two denotations of this term, 'world'; namely, its subjective and its extramental denotations, whose interval modules fairly differ. To this purpose, let us convene from this point on to reserve the term 'world' for indicating (save in quotations) 'mental world', *i.e.* every set of mental contents into which a mind has become itself differentiated. We will use instead 'subuniverse', confessedly a graceless name whose valuable coinage is often attributed to J. A. Wheeler, or 'macroworld' when it matters to forget about the 'virtual' particles created from sub-indeterminacy fluctuations in energy, for denoting the observable nature where minds and time are found. Associated with these two terms let us form the pairs *moment-world* and *instant-subuniverse*, so as to apply here the convention deeming

"physical instant ... a very minute period considered the ultimate modulus of transformational change, namely the minimal interval over which a causal transformation is at all possible or might be marked off by two different instants, [while a moment is] the minimal transformational resolution or time acuity of minds, which is observed to stay in the order of one hundredth of a second. We do not live and remember physical instants; we live and remember moments, and the difference between an instant and a moment is a dilation that stretches physical instants an ascertainable number of times." [6]

1.4. Features of presentisms. Presentism, taken (not to mix up the issues of dimensionality of the universe in relativity and in, say, Planck-scale models) as only

related to the macroscopic aspect of the subuniverse, when conceptually refined, features three defining tenets:

1. The macroscopic subuniverse or actuality displays itself as a *plurality of spatial localities* (though, nevertheless, current presentisms may recognize that space is not a cosmologically fundamental but secondary occurrence). Space spreads forces over three dimensions; this essay will not discuss the dispersion of forces over extra dimensions collapsed into tiny magnitudes that might be necessary to unifiedly describe electromagnetic, gravitatory, and nuclear forces. Yet one might note that although presentist descriptions can accommodate non-local effects, *e.g.* quantum entanglements over macroscopic distances, in order to reveal relativity (also) in presentisms these forces' action carriers must be conceived as translocative: no action at a distance or non-local extramental effect is acceptable. Whence to produce relativistic descriptions presentists should grant that, in each of those spatial localities, the frame-invariant causal efficiency of therein-localized components locally generates changes one by one, and by recording such changes observers may reconstruct series of events successively occurring in worldlines.
2. Such a subuniverse or actuality thus *exists only at the present instant and exhausts itself in its being present there in full entirety*, so that all of the components of every macroscopic item cannot help but coexist at the same instant yet never on more than a single instant. Their coexistence enables them for affecting reciprocally through frame-invariant, efficient causal interactions which preclude that an event, which is now present, was future, and will be past, in addition modifies its being earlier than some and later than some of the other events. Yet, as mentioned in the next paragraph, this coexistence-stemmed capability to efficiently deploy invariant relationships of precedence and succession remains unused in certain presentist scenarios which posit causation to be logical, rather than efficient. In any case, past and future components, items, events, or situations do not exist and as a result not either coexist and cannot causally interact. Specifically, no past or future situations, items, events, or components might be coexistent with the present ones which, rather, are able to frame-invariantly engage in causal interactions between themselves. In Indoeuropean-rooted languages past and future nonexistence might somehow more confoundingly be expressed with a double negation, saying that past and future '*are*' in a certain way or certain '*mode of being*', namely that they '*are*' inactual – a supposed '*mode of being*' oftentimes further split into two varieties, so that past states '*are*' inactual and unmodifiable or blocked while, instead, future situations '*are*' inactual and modifiable.
3. This subuniverse or actuality is three-dimensional, meaning one of the following alternatives:
 - 3.1. A certain version of presentism, of pronounced Platonist affinities, pictures this subuniverse or actuality as *sheerly* three-dimensional. In this outlook the unchanging universe has no time-like thickness at all. It thus lacks and always lacked any intervalic extension of actuality which might count as a primary time dimension secondarily vanished as the magnitude of such a time dimension fully collapsed. As in this scenario no fourth dimension displays any span, the present instant's time-like duration is inherently zero; of course, it cannot be navigated. So in this

special presentist outlook absolute uniform motion may exist but the universe or subuniverse houses no causal change; essential 'virtualities' stand for efficient causation, which – like any change it shapes – is held as pure appearance and sensory sham. Absence of frame-invariant efficient causation allows that an event, which appears now as present, appeared as future, and will appear past, in addition modifies its being earlier than some and later than some of the other events. It is unclear if inertia has to exist in it.

- 3.2. A second, different version of presentism *acknowledges a fourth dimension*, although one whose span is fairly meagre. In this fourth-dimensional version of presentism the changing situations whose sequential delays compose an interval do not exist simultaneously, but the subuniverse nevertheless also possesses a particular time-like thickness which – at least in our subuniverse – chances to be the same that also works for physical changes as their ultimate feasible interval unit. Thus the present instant's time-like extent is not zero. This intervalic inner extension of actuality (Fig. 2 below) counts as a time dimension whose span or magnitude collapsed down to the extent that, for every locality and segregated modality of interaction (or physical force field), its residual span accommodates no more, but not either less, than one action of physical causation at a time. Thus also in this version of presentism this fourth dimension is unnavigable and neither exception of waiting nor time travel may either occur, but its span is not nil [3] and all motion is a causal transformation moving with respect to timelike-thin space, *i.e.* it is relative. The action units of frame-invariant causation, by their matching the actuality's collapsed four-dimensional span, can efficiently run sequential transformations of the timelike-thin actuality precluding that any therein-enacted event modifies its being earlier than some and later than some of the other events. Other subuniverses' buildups might include this fourth dimension either less collapsed or, even, more collapsed, having varied its span with reference to fundamental requirements of physical action – with the result that in those subuniverses, whether by excess or by defect, causal sequences (of transformations in time) could not be sustained, whereas in our subuniverse, because of the specific magnitude of such residual span, change exists.

1.5. How do we know that change is not illusory? Our perception of the external subuniverse reveals it as being indeed changing. The very causation of this change, however, remains for the most part unobserved: in 1905-1906 Ehrenfest and Einstein first realized that Planck's derivations work because physical change comes in integer multiples of $h\nu$ and a little over fifty years later Crocco recognized that it entails the unobservability of physical causation itself. In other words, under observation the efficient causation of physical change behaves as if coming in microphysical packets which are discrete, *i.e.* which cannot help but annihilate themselves to effect the change.

This discreteness, or whatever determines that behavior, has thus been pinpointed [2, 3, 6] as the reason why one does not observe the very causation of such a change (whether microphysical or macrophysical) but just the changes

done, except when the change is originated by one's own mental acts – as in the case of changes derived from the observer's voluntary behavior, such as the progress in one's writing or painting – and is observed on time scales large enough, *i.e.* through not too tight time windows (as commented below). This makes possible that, as ascertained on consistent observations (summarized, for example, in [7]) carried out over the last three-quarters of century and grounding the quite new academic field called genetic epistemology, whereas the very causation of outer changes remains for the most part unobserved, the concept of time and its three components – past, present, and future – are nevertheless inductively formed from what we directly perceive: namely, as a part of the individuals' intellectual development and interactive acquisition of epistemological adequacy to effectively operate in the surroundings. In those limiting circumstances, observers gain their metrical impression of duration from the time needed for their mental acts [cf. 8, p. 633].

These modern results about the mechanisms of intellectual development, a development which each individual must work together with the surroundings, make clear that time not only elapses for mental accounts, but also outside of minds: viewing time as purely subjective is no longer tenable. Its untenability has become evinced, among other facts [3, pp. 81 (fn. 31) and 927], by the developmental acquisition of the animal minds' epistemological adequacy, whereby "Heraclitus says that the awake share a unique world, while the asleep turn themselves toward a private world" (Plutarch, *De Superst.* 3, 166 C). In order that, in contrast, time be purely subjective, such adequacy of the mental contents – on which rests the natural selection of suitable nervous systems' and cerebral architectures – should rather be achievable through bare contemplation, as an 'infused knowledge' acquired just by contemplating the things' reciprocal relations, not interactively: as if an inborn-paralyzed child could be intellectually bred by exclusively watching television screens. The need, for humans and at least the other amniotes (*i.e.*, the mentioned mammals as well as birds and other reptiles) to acquire befitting knowledge of extramental occurrences, of sequential interactivity² wherein the mind-originated probings enact absolute motion, entails that time, indeed, runs efficiently in extramental realm.

1.6. *Positing that 'everything' exists likewise in regard to time.* This settled the issue of the existence of absolute motion in nature and allows to proceed on

² Brain electroactivity mediately [6] generates phosphenes which intonate the mind circumstanced therein. How to map the surrounds with them? By actively probing the environment, we found which phosphenes vary under our actions and which ones rather behave on their own. Through this discriminative process, empsyched organisms developmentally grow their intellectual acumen, adjusting mental contents to outer reality and developing an operational "concept" for every class of encountered things. These are then recognized, on new encounters, on their expected behavior in response to the operations one could do with it -- *e.g.*, computers aren't eatable. Those operations which one avail (namely: can perform) form a system whose main feature is structural equilibrium - one can do some operation as well as the inverse one, so doing and undoing some changes. Others changes, nevertheless, resist; resistences reveal features internal of the things referred to through the phosphenes: what the "real things" can in their turn do. This equilibrium (mapping one's and foreign availabilities), structure (of operations), and genesis (developmental) are the main features of intelligence. Both mind operations and mind reactions (mind-intonative phosphenes) are in the ontic consistency of mind; the brain's electroneurobiological structure is just one of the means to generate the latter ("sensations").

topics which, as the one of simultaneity, logically come later. One should accordingly start by recognizing that extramental reality, namely how things fit together independently of the minds, changes in due course. And indeed, Heraclitus argued that the universe is perpetually changing, though he seems not to have explicitly discussed the connectionship of change and time. It was attributed to Heraclitus the opinion that everything flows (*pánta rheí*: this thereby-appalled Plato ascribed to Heraclitus in *Cratylus* 402 a; cf. Plato's *Theaet.* 152 d, 160 d), everything ceaselessly dances in choir (*pánta chórei*: this uplifted Aristotle ascribed to Heraclitus in *Topikóí...* 104 b 21 ss) [for a popular expose cf. also 9, p. 65]. Such a dependence making every macroscopic reality likewise contingent on time and determined by the temporal engagements of the flowing everything (*pántoon ... reóntoon*, Plato's *Cratylus* 439 c) is temporarily contested by scholars pointing that minds are xenochronic [2, 3, 6]. With this term, they assume that

"natural science describes... realities of two kinds: observers, also called minds, which do not generate time inside them (but may emulate any outer course, an aptitude that may be called xenochronism), and the set of extramentalities, which does it (and interactively assists minds to emulate outer evolutions). While in minds memories persist because they do not exist within a coursing of time that could alter or erase them, extramentalities evolve because the transfers of causal efficiency make a microphysical time course which the inertial mass of some but not all elementary particles extends into sizeable scales" [10].

But this splitting, exposing that not everything of what natural science describes behaves identically as regards time, is quite recent. In ancient times, almost two centuries after Heraclitus, Aristotle effectively arrived at the conclusion that 'everything' exists likewise in regard to time. Positing this notable uniformity was not a option, as it was compulsory in order to found biology. He

"... conceived knowing, *gnoeín*, as a variety of metabolic assimilation only for the purpose, and with the precise objective, of being able to compose a unique descriptive series with which to delineate the full variety of living beings – by comparing species among themselves and comparing the developmental sequences of individuals. With this conceptual tool, Aristotle was able to achieve his purpose, of attaining conceptual means suitable for unifiedly and uniformly describing the living beings found in nature in all their possible forms. His informational view of knowledge, presenting it as a variety of metabolic assimilation, is thus why Aristotle managed to institute biology as a unified science. ... [I]n view of his mentioned purpose, it was uninteresting to detect if within the series of organisms animated by a vegetative-sensitive soul the individuals of some species included an existentiality circumstanced to sense and move its body. This is the case of a dog, for example. Other organisms lack such an existentiality in charge of biological functions, for example a starfish – or its common ancestors with the dog, if Aristotle could have minded of them. ... These animals lack... any knowledge inasmuch as experience: in these animal species having an Aristotelian soul but not circumstancing an existentiality their 'knowledge' is mere information, gnoseologically uncharacterized – and only metaphorically called 'knowledge' by external observers interested in keeping Aristotelian homogeneity for the biological series." [ibidem, Section 2]

1.7. *Positing that 'everything' composes the only present 'now' that exists.* Therefore, Aristotle's description would not embrace the mentioned heterogeneity (of xenochronic minds and time-generating macroworld) as his description could not distinguish between existentialities or subjectivities and bodily information. (As notorious, he was also unable to tell between a plurality of existentialities leaving aside the difference in their mental contents [3, chapter 1.6]). He was rather to deal unifiedly with all organisms, whether lacking existentiality or subjectivity or instead possessed with it, so setting a single continuous series of *psychai* ('souls') just differing in informatical terms. Aristotle further arrived to the conclusion that such *uniform* 'everything' exists only at the moment 'now' since it is this moment that "connects past and future time" [11, p. 301] which themselves do not exist: "one part of [time] has been and is not, while the other is going to be and is not yet" [11, p. 297].

Besides so portraying all realities in nature – as uniformly behaving with regard to time and composing in this way the only present 'now' that exists and in such presence exhausts itself altogether – Aristotle made another contribution to conceptually refining the presentist view, by asserting that nature is three-dimensional: "A magnitude if divisible one way is a line, if two ways a surface, and if three a body. Beyond these there is no other magnitude, because the three dimensions are all that there are" [12] (see also [13]).

2. Physical and philosophical connections

2.1. *Instant 'thickness' and causation.* The three defining features of presentism – asserting that the subuniverse is causally efficient to transform itself successively through local change (a feature turned macroscopic with the acquisition of inertial mass by only a fraction of elementary particles [3, 10]), exists only at the present instant exhausting itself completely in such a presence, and is three-dimensional or has its fourth dimension collapsed – are intrinsically linked: if the macroworld is three-dimensional it exists only at one instant of time and vice versa; the time-like thickness or 'duration' of the instant in such a changing macroworld is determined in relation to features of microscopically local causation. Namely, in the physical-causation-acknowledging variety of presentism this time-like thickness of the instant admits neither causal sequences nor inchoations: it can let in neither more nor less than just one elementary process of energy transfer or efficient causation; that of course refers to what may be described as the very transfer of an action carrier of a force field, not to the response interval or lagging of its direct effects behind the causal action packet's instantaneous absorption, *i.e.* the 'characteristic times' taken by the transitions caused [3, 6].

2.2. *Denial of efficient causation affirms 'to be' as logical predicability and causal efficiency as pure outward show.* Instead, in the physical-causation-denying, antichronic variety of presentism, for which transience is unbearable and on no account deemed basic, the instant's time-like thickness does not exist; 'to be' boils down to mere predication of attributes (explained below) rather than fundamental enactment; determinations come only from logical relationships, and physical change is sensory hallucination: in no way real transformation. As the therein-revolting prospect that situations could really flow is altogether denied, reasonings

are supplied in order to repute illusive the irrevocability of time. Augustine of Hippo, still importantly influenced by Plato's antichronic outlook which instances such denial of reality to time elapsing, made an early move toward realizing that link by attempting to ascertain the duration of the 'now'.

Augustine decided that the present moment cannot have any duration: "In fact the only time that can be called present is an instant... For if its duration were prolonged, it could be divided into past and future. When it is present it has no duration" [14, p. 119]. One should remark that, in order to avoid its being thus divided, there is no need that it completely lacks duration, as Augustine supposed, since enacting any division in extramental time demands causal efficiency, so that a time-like duration shorter than the time needed for enacting causal efficiency suffices to avert that "it could be divided into past and future" [3, pp. 309-312]. Yet Platonisms need to pronounce causal efficiency just sense deceit and pure outward show, reality being rather determined by the essential virtualities of timeless Ideas.

2.3. Instant's duration and causal efficiency. One should remark, too, that this instant needlessly supposed of no duration, *i.e.* of no intervalic extension, is thus placed by Augustine into the same scenario that spatial extension. This combined move presents the universe as sheerly (and, literally, most narrowly) three-dimensional – otherwise, its time-like thickness makes a collapsed fourth dimension wherein *only contingently* may navigation become unworkable: the nature of such a fourth dimension's residual span is still alike to that of space – and sustains the antichronic outlook, *i.e.* Platonisms' denial of reality to irreversible time.

But the topic is intricate, so that to visualize the ties between the three-dimensionality of the subuniverse and its existence only at the instant 'now' imagine that 'the present moment' names some finite duration. For the sake of the argument let us forget time courses as determined by physical causation and, arbitrarily, let that duration be some fixed number of minutes. (For instance, Petkov [1] chooses ten seconds as his example).

As these minutes are not further distinguishable into present, future, or past all of them are present. Thus every thing and the whole subuniverse would be given as a whole, or exist in its entirety both 'at once' and unchangeably, during all of the (rather, our clock's) instants composing the imaginarily protracted time-like thickness of the 'now'. Everything, even if instantaneous, would at least be likewise extended in time. For example, every mobile item would at once exist at all spatial points of a distance it travels for the fixed number of what we call minutes. Nevertheless, macroworld's items that are extended in time are four-dimensional, not three-dimensional. Presentists often remark that we seem to perceive a realm of items not appearing to exist at more than one instant. Whence not seldom it is thought [*e.g.*, 1] that on the presentist view the fact that the subuniverse "is regarded as three-dimensional *implies* that the present moment *must be*" an instant with no inner transformative course that could be called duration or 'time taken by such a transformation'. This entails that in describing presentism one cannot forget (as we did, for the sake of exemplifying) time courses' being determined by physical causation, because the interval-like thickness of reality is to be linked with the minimal possible 'delay' that physical causation imposes in order to enact change [3, 6]. (Only so may a time-like thickness neither to 'hang' nature's transformations by turning causal courses into a 'legato', *i.e.* by enmeshing

the physical causation of change, nor to prevent causing transformations altogether.)

2.4. *Frame-invariance at the efficient causation's core.* Whatever may count as physical causation is of course to be frame-invariant (*i.e.* no perspective could exist from which it vanishes or cancels) and to come about as every one of the reaction-producing modalities for exchanging energy in a certain energy range. As an interesting instance, when Crocco recognized that the fact that physical change comes in integer multiples of $h\nu$ entails the outer unobservability of physical causation³ (which thus displays the extramental transformations as if they were constant conjunction or structural spectacle delineated by certain connectability function, κ , defined as *causal*), he utilized the frame invariance of causation for presenting sensing as a new fundamental action of nature by way of pinpointing the requisite *conservation of feelings* in *any* relativistic description of the sensually-interacting tissue as physical system⁴ [*e.g.* of the sensually-mediated lengthening of any biosphere's trophic chains, summarized in 3], not without highlighting in advance that the very Plato, in *Sophist*, spotted this frame invariance – later formalized in a symmetry theorem by Emmy Noether [3 § 1.5.5, pp. 465-476] – as the mark identifying that which is not mere appearance and never can be such. Otherwise, *i.e.* if causal efficiency not involved frame invariance, perspectives could be found in which the causal relationship of a course of physical events would appear uncalled for.

Also of interest for the next discussions is mentioning here that, as evinced by the empsyched animals' action (namely, their mentioned elongating the biosphere's trophic chains) that at its outset detaches biological evolution from its minimal course [10; Fig. 3 in 3, p. 900, and references therein], observable efficient causation, *i.e.* the observers' own one, is of the same nature that the unobservable efficient causation. As François-P.-G. *Maine de Biran* first remarked in 1823-1824 [6], within the knowledges that minds gain, a quite exact line demarcates what there is of passive and of active. In the process of depicting the subuniverse through the efficient interaction and discrimination of this observable causality from the unobservable causality concealed at the transformations of the items found in the surroundings, this demarcation is operative already at the start, as recognition of the observer's own reality in the cogito (*i.e.*, in her own action of attentional refocusing resisting itself; the cogito is not a reasoning or an inference, see Appendix). Whence the importance of knowing that the very Plato himself, in his just mentioned book *Sophist*, also took notice and made argumental use of such a cogito, which remained unidentified until 1979, when Mario Crocco – in a later phase of his work – exposed it by withdrawing from the text a cloaking

³ Thus leaving for observation only the causation that also observes itself, *i.e.* minds – which are semovient sentiences, namely realities that sense their own transformations and cause some of them [*cf.* 6].

⁴ "Just likewise – because the requisite conservation of feelings in any relativistic description of the sensually-interacting tissue as physical system must, by Noether's symmetry theorem, correspond to certain symmetry in the ways in which nature can be non-indifferent to itself, a symmetry which must turn their display periodic and which the brain states that differentially cause them must reflect – the regularities of interobject [*i.e.* intramental] action seem far more comfortably elucidable after having mapped the dimensions, ranges, and amplitudes on which their close extramental effects vary" [3, p. 566; square brackets added].

interpolation added in the XIXth century by a modern 'Friend of Forms' [3, pp. 81 (fn. 31) and 927]. Through this unique efficient causation offered in nature, localized observers may build the developmental operativity that allows referring semiosis (the action of signs) to ever more distant present objects.

2.5. Efficient causation brings into physics observers and semioses. So found by a variety of modern scientific endeavors, neither localized observers, nor their time-consuming intellectual development and semioses, can any longer be excluded from the physical science's description of such a nature. In this contemporary scenario, as discussed below, special relativity therefore is, or ought to be, a representation as well as an interconversion procedure of all the localized minds' possible perspectives ("an infinite number of spaces") or reference frames of the subuniverse attainable through such a semiotic reference, and not a direct representation of the distance-involving subuniverse's states.

In this way, in sum, on the presentist view which recognizes physical causation the fact that the subuniverse is regarded as three-dimensional implies that the present moment must be an instant with the interval-like thickness of the minimal possible 'delay' demanded by such a frame-invariant physical causation – turning such subuniverse fourth-dimensional. This constraint, as already hinted at, interestingly varies when causation, rather than physical, is taken to be non-physical, in the style of the logical relationships among concepts or Platonic Ideas.

2.6. Physical causation substituted by non-physical relationships. Such logical 'causation' takes no fraction of time to set up its results (time or transformative sequenciation is indeed illusory in that scenario), and of course poses no requisite of frame invariance, which would be superfluous. In this case, one lacks any reason to see, and does not see, that to elude that the present instant "could be divided into past and future" there is no need at all of positing that the instant's nature be nondurational, rather than a collapsed, contingently unnavigable yet extant fourth dimension. On the other hand, as Petkov [1, page 2; pages are from the Pittsburg website's version] says, "Augustine could not have possibly realized that the duration of the moment 'now' must be zero, as he concluded, in order that" other conditions become secured. Let me put these further conditions as that, all at once, the macroworld be three-dimensional and physical causation gets substituted by non-physical relationships ('virtualities') between Platonic Ideas – so enervating by the same token past's irredeemability and sensuousness' allure. But the presentists who also want to be Platonists, or rather nowadays enlist themselves in the Pythagorean-Parmenidean-Platonic-Puritanical⁵ tradition, should see this articulation lucidly.

Appreciating the bond between the three-dimensionality of the subuniverse and its existence *only* at the present instant puts on view that, if time-courses are disconnected from time-generating physical causation and for that reason the instant's duration is taken to be zero, then past and future do not exist in any sense in the framework of such a presentist view. The fourth dimension is absent.

⁵ "Puritanical" here refers to the Greek Puritanism whose communities become widespread in hellenized societies from the -III to the VII centuries. This Hellenic rigorism shows a general attitude toward time and the body also seen in not a few disparate cultures, including the British Puritanism and British Platonism of early Modernity. Cf. [15], chapter five: "The Greek Shamans and the Origin of Puritanism".

On the contrary, if efficient causation is recognized as enacting time courses, it is also recognized as determining both the time's metrics and arrow, and in such a presentism the present instant (the non-spatial thickness of macroscopic universe) is possessed with a time-like duration whose two borders abutting to non-being, *i.e.* the one toward causally closed situations and the one toward transformable situations, feature different properties [3, § 1.3.8 "The Time-studies Framework", pp. 309-314] that exhibit an exhaustion of causal efficiency – of which exhaustion other instances are known in nature [6].

2.7 Is the instant itself dilatable – like intervals? In such a view, the past and the future are merely sets of previous and forthcoming states of a three-dimensional subuniverse which exists *solely* at the present instant. But these states do not stand alone or exist on their own⁶. The universe is not fundamentally 'split' into space and time but such dimensions come from the more fundamental unique causation offered in nature, *i.e.* the frame-invariant efficient enactment of alterations, and then streamline it to unfold diversely. Through this unfolding the macroworld becomes to consist in its three-dimensional, force-dispersing [3] extension (of variable magnitude, so that fresh space may be continuously generated amid adjacent localities, *e.g.* with the subuniverse's expansion) and its time-like, causation-harboring thickness (of variable magnitude, *i.e.* one that may occur more or less collapsed between different subuniverses) whose nature and intervalic constriction could not exceptuate it from abiding by the kinematic relativistic constraints. This last, important feature was recently summarized in [6] and here can be convenably quoted (with permission) at some length:

"For durations that can be measured, one can empirically verify that a certain number of physical instants, *i.e.* a sequence of possible causal transformations, must appear dilated if the total duration is assessed from the sequence recorder (a clock) of moving observers. The antichronic outlook entails assuming some impediment that stops this dilational effect for smaller numbers of physical instants. In its view short intervals ought not to get dilated, a ban specially applied onto the single instant.

The groundlessness in conjecturing this impediment becomes apparent when we consider that no force in the observable universe is efficient to cause a transformation in less than about 10^{-25} second (imagine 0.000 000 000 000 000 000 000 000 1 of a second), a duration that may also be expressed as its equivalent, namely as

⁶ This non-existence of past and future states is not to be mistaken with the Aristotelian status of the realities belonging with non-substantial categories. Neither for Aristotle, nor for Peripatetism, actual existence of past or future is a possible, *i.e.* something that through potency (*steéresis*) might gain actuality; but that which, not being, cannot either be: Plato's *ouk óntos ouk ón*. Past and future states are essentially and incorrigibly inactual. In Aristotle's categorial schema, states are accidental in character. States, 'accidents', or manners of being do not exist on their own without the entity which they are states or affections of, so that this entity remains an unchanging subject of change (a subject and its attributes or predicates). A substance as such must be changeless and any changes can only be *in other features (accidents) which are not essential to the underlying 'changelessness' of the entity or substance*. But although temporally-thin universe (*kósmos*) is a substance in Aristotle's terms, the actual existence of its past or future states is not an accident occurring (*symbébekon, accidens*) onto such a substance. It is just a nonoccurrence; one, moreover, which no potency could redeem.

some 10^{19} Planck instants. Every transformation in time is, thus, currently ticked on intervals always larger than this one. Such a brief interval is accidentally unmeasurable (because any recording-change in a clock must be caused by some physical force, but no observed physical force could so quickly give rise to any effect). Nevertheless, nothing suggests that this $\sim 10^{-25}$ second interval or a fraction of it is intrinsically noncompliant with the Lorentz-FitzGerald transforms.

Put differently, nothing suggests that this $\sim 10^{-25}$ second interval or a fraction of it be refractory to become dilated and expand in due proportion any eventual marking sequence that subdivides it, revealing even the duration of those of its fractions (physical instants) in which no subdividing mark could ever be set – which if dilated are to appear as a still discrete, causally impenetrable blank when appraised by moving observers. Where and why might any such hindrance to dilation be expected to begin, barring the special-relativity transforms' validity for fleeting intervals? The antichronic outlook demands this impediment in order to judge the physical instant unreal. In contrast, it is often thought that the Planck instant or Planck time $(\hbar G/c^5)^{1/2} = 5.3916... \times 10^{-44}$ second, a minute fraction of a second (actually requiring forty-three zeros after the decimal point before starting with the mentioned numbers), may name a limit for any possible physical force to be efficient in causing a causal transformation; namely, that the Planck instant denotes the interval-like thickness of actuality, whose causal transformations – always taking many of such instants because of the cosmologically acquired weakness of efficient forces – make real time. But this prospect is dismaying for an outlook that struggles against time. It rather wishes for a 'block' universe where all intervals were simultaneously real, the actually present instant in no way different from the past and future ones, and time elapsing just subjective or illusory."

2.8 The block universe. Rigorisms such as the Pythagorean-Parmenidean-Platonic-Puritanical tradition offer another view on reality that differs *ontologically* from presentism – pinpointing and decrying the senses' deceitfulness. It is the block universe view. In it, to borrow a remark by S. F. Savitt, "There's No Time Like the Present": literally so, indeed, as there is no concept of absolute present. Irony comes to adorn this keen remark from the paradoxical circumstance that in such a tradition the assertion, "There's No Time Like the Present", by no means expresses any jubilant reception of present time with corresponding unconcern toward inactual past and inactual future, in the style of the notorious *Carpe diem!* The assertion, on the contrary, aims precisely to deny that present time enjoys any privilege at all (as it may be the efficient exercise of frame-invariant, absolute transformative causation) over nonpresent, only conceivable situations which nevertheless are judged 'perduring' somehow or somewhere, beyond mere imagination, as purported 'temporal parts' of all what senses find enacted at the present.

This denial of present-time's exclusivity thus contends that things are also made of 'temporal parts' 'perduring' away from private fancy, so as to be encountered or having been encountered by spatially localized observers in other times. In such a subuniverse the definition of simultaneity is necessarily only conventional and there are no objective becoming and time flow. This denial can be

traced back, not to mention cultural events from early Antiquity and even Mesolithic times [2; 3, pp. 567 ff.], to the eternal and unchanging being of the Eleatic school of philosophy [a panorama in Ref. 9, Chap. X] and to the rigorist longings [3, p. 312] for an exemption to waiting and a retrieval of olden days along with a defense against envisaged dissolution of the very scholar by time – *tempus edax rerum*. Petkov [1] points out that "Saint Augustine also believed in an everpresent eternity which, however, was not accessible to [premortals] humans [14].¹⁵In 1884 Hinton wrote about a four-dimensional macroworld in which the ordinary particles are regarded as threads [16,17]." In each of these threads no physically efficient causation was to work to compose time from successive changes. This instances still another linked, important feature: the denial of efficiently-causal time usually serves to put causal efficiency only on thinking courses and, thus, to fancy that rigorous thought is productive of what it thinks.

2.9. *Block universe, unstoppable thought*. This 'poietizing thought', as it is called, is deemed to occur whether within individuals (as claimed by subjectivisms, *i.e.* the extramentalities-denying worldviews asserting that observers inhabit a "gnoseocapsule" [3 § 1.3.24: "Intertwining agencies", pp. 388-392; excerpts are provided hereinbelow, in Appendix]) or in the individuals' assimilation (made by subjectivism-transcendentalisms, *i.e.* the subjectivisms logically resigning the observers' plurality into the unity of a single transcendental subject) to a primordial *Lógos (Ma'at)* no longer tied up to a more ultimate, enactive Father. The latter ideological scheme is often captured, *e.g.*, in myths such as the one of Zeus maiming Chronos or outlooks such as those of German Idealism, habitually epitomized in Hegel. This 'poietizing' is a condition – and harrypotterish ability to summon extramental things out of reasoning – oftentimes subserved by the view that 'being' is tantamount to a mere confluence of predications⁷ (as Anselm of Cantorbery 'Proof' exemplifies: "God exists because its concept enlists every perfection: as being is more perfect than not being, God's own concept must enlist being, thus proving that Gods exists". As to humbler realities, rather, predications may be 'properties' or 'proper predicates' such as futurity, presentness, and pastness. It should be eagerly remarked that if 'being' amounted to admitting predications, nothing essential about the present-now could remain outside the realm of predicate-arranging science). Whence this antichronic outlook is often detected in those subjectivist and subjectivist-transcendentalist philosophies – and the 'P' of 'poietizing' becomes added to this tradition's unpronounceable acronym, 'PPPPPP'⁸.

⁷ The concept of essentialist and efficient causations are not identical, presenting realities capable of producing the same results, since one views 'to be' as a predicate and the other as an enactment; for example, it is by no means clear if a sheerly three-dimensional universe might encompass inertia.

⁸ In Spanish, a language in which quite attention has been devoted to explore this topic, a further "P" chances to be attached, adding to the pathetism of this acronym's unpronounceableness. "PPPPPP" stands for "*pensamiento poietizante pitagórico-parmenídeo-platónico-puritano*".

3 The uncollapsed four-dimensional subuniverse

3.1. *Birth of the scientific idea of block universe: 1908.* In the quarter of century ensuing Hinton's work, a number of rigorisms voiced loud their misgivings about presentism. Petkov [1] affirms that the scientific birth of the block universe view, however, took place in 1908 when Hermann Minkowski proposed that space and time should be united into an inseparable four-dimensional entity – spacetime – which he called 'the world'. Minkowski began his talk at the 80th Assembly of German Natural Scientists and Physicians with the now famous introduction:

"The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth Space by itself, and Time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality" [18, p. 75].⁹

It should be pointed out that special relativity, and more precisely its four-dimensional formulation given by Minkowski, is *logically* contained in Galileo's principle of relativity (with a single additional assumption – that the speed of light is finite, which was determined experimentally in Galileo's century). This makes only more sensible that, as Petkov [1] observes, Minkowski viewed the idea, of the subuniverse as being not objectively split into space and time, as worked out from experimental evidence and not just as an alternative representation of special relativity. In fact no such alternative was in sight. "That is why a genuine understanding of special relativity could not be achieved without regarding spacetime as a four-dimensional space whose four dimensions are *entirely given*⁹, like the two dimensions of a plane." [1, p. 3].

I think that the nature of this restriction is worth close inspection. For, is this constraint in any sense comparable to reasonably imposing adherence to a certain necessary procedure in order to use a calculation software – or rather to arbitrarily imposing loyalty to, say, a certain discretionary worldview, for attaining the same purpose? As advanced in the title, we will see later that it rather constitutes a Kantian *condition of possibility* for relativistic calculations, one which does not reveal anything about the 'things in themselves' that Kant would have labeled 'noumenon'. Minkowski might have hinted at something comparable to the previous sentence's first part but he certainly did not take on the second. Minkowski's opinion amounted to counting on the possibility that one might ratiocinate backward from non-theoretical data to some model or preliminary theory. Yet, non-theoretical data have not been found anywhere (see below, § 4.7); first and foremost, because once observers attain some intellectual development they cannot help but deal with their apperceptions: no longer with 'pristine' sensations. This is specially delicate concerning ontological conclusions.

⁹ At this juncture Petkov [1, footnote 2] adds: "It might appear tempting to regard the temporal dimension as not entirely given, but if this were the case spacetime would not be four-dimensional – one cannot talk about a four-dimensional entity if all dimensions are not equally existent. Spacetime is not like space since the nature of the temporal dimension is different from the nature of the spatial dimensions, but this has nothing to do with the *equal* existence of all dimensions of spacetime (like the different nature of physical objects and phenomena has nothing to do with their existence). In this respect I completely share the position of Taylor and Wheeler regarding the temporal and spatial dimensions of spacetime: "Equal footing, yes; same nature, no" [19].

Minkowski's outdated opinion neglected that the collection and recording of raw data is always theory-determined, as is the interpretation of data, and even methodology. Does this atypical constraint endorse – or either disallow – the widely accepted view (discussed below) that "relativistic mechanics does not carry a particular ontological interpretation upon its sleeve"?

3.2. *Primary belief: the block universe view as empirical.* Petkov [1, p. 3] observes that Minkowski left no doubt that the idea of spacetime should be understood in this way – as an inseparable, entirely given four-dimensional entity – by pointing out one immediate consequence of that idea, namely that one could not talk about *one* space any more. Minkowski in fact noticed that "neither Einstein nor Lorentz made any attack on the concept of space" [18, p. 83] and stressed that the idea of many spaces is inevitable in special relativity: "We should then have in the world no longer space, but an infinite number of spaces, analogously as there are in three-dimensional space an infinite number of planes. Three-dimensional geometry becomes a chapter in four-dimensional physics. Now you know why I said at the outset that space and time are to fade away into shadows, and only a world in itself will subsist" [18, pp. 79–80]. But, although (as Petkov notes) Minkowski demonstrated that the consequences of specially (kinematically) describing the relativity of simultaneity (length contraction, for instance) found a natural explanation in the four-dimensional spacetime, I find significant to remark that Minkowski did not find it necessary to argue that these consequences were possible only in a four-dimensional subuniverse with a non-collapsed realm housing at once all the changing states of the cosmos.

Petkov continues: "Unfortunately, the depth of Minkowski's idea does not seem to have been immediately and fully appreciated – as evident from Sommerfeld's notes on Minkowski's paper: '*What will be the epistemological attitude towards Minkowski's conception of the time-space problem is another question, but, as it seems to me, a question which does not essentially touch his physics*' [20].

About two decades after Minkowski's four-dimensional formulation of special relativity Weyl appeared to have realized that Minkowski spacetime is not merely a mathematical space but represents a four-dimensional external [subuniverse whose being entirely given at once] is not directly reflected in our perceptions: 'The objective world simply is, it does not happen' [21]."

Einstein added in 1952 a further appendix, "Relativity and the problem of space", to his "Relativity: The Special and General Theory" in which, as Petkov also notes, Einstein seemed to have arrived at the same conclusion: "It appears... more natural to think of physical reality as a four-dimensional existence, instead of, as hitherto, the evolution of a three-dimensional existence" [22]. However, neither Weyl nor Einstein showed that the uncollapsed four-dimensionality of the subuniverse, and *identical* existence of a plurality (assumed a non-bounded number or infinity) of three-dimensional spaces, 'temporal parts' of everything, or "present-nows" each with a different distribution of physical occurrences, unavoidably follows from the consequences of special relativity.

3.3. *Debate on the empirical grounds of the block universe view.* As it is well known, Rietdijk [23], Putnam [24] and Maxwell [25] argued that relativity of simultaneity – one of the basic underpinnings of special relativity – *inevitably*

assumes an uncollapsed four-dimensional subuniverse. None of them regarded as uncollapsed, or even as boundable by opposite and intrinsically different frontiers with non-being [3], the timespan or extent of the fourth dimension being considered; none of them, either, offered the detailed calculations today customary for justifying that, *e.g.*, the twin 'paradox' is not paradoxical at all¹⁰, by showing that, in both backward and forward logs, the 'transframing' stays smooth and at every instant and accounts for the observable results. However, the argument was validly criticized in two occasions by Howard Stein [26, 27] and Petkov mentions authors [28] claiming that Stein "has settled the issue". Petkov's work correctly shows that, in certain sense, Stein's objections not only do not disprove the argument but further reinforce it. This brings about very interesting consequences and a bridge between relativity and semiotic researches, discussed in Section 4. Section 5 studies a more general argument by Petkov, showing that the consequences of special relativity and the experiments which confirm them would be impossible if the subuniverse were three-dimensional with a present-'now' of zero time-like duration and if the existence of the objects involved in these experiments is extramental, namely observer-independent or physically 'absolute'.

Special relativity is a kinematic and not a dynamic portrayal of the behavior of physical objects. Namely, its portrayal, although can perfectly take up acceleration and represent its materializations as curved worldtubes, does not seek to include or refer to the forces enacting causal efficiency, upon the finding of whose operative running it could be attributed a non-zero time-like duration to the three-dimensional actuality – as its 'thickness'. Taking this into account, the mentioned impossibility shows, as Petkov puts it, that only the block universe view does not contradict the experimental evidence which supports special relativity. Upon this result he explores whether or not an equivalence of three-dimensional and four-dimensional presentations of special relativity implies an equivalence of three-dimensional and four-dimensional ontologies; I discuss and reinterpret this in Section 6.

4 Has Stein Disproved the Rietdijk-Putnam Argument?

4.1. Summary of the Rietdijk-Putnam Argument. To analyze Petkov's view of Stein's objections, let me first go over the main points of the claim that relativity of simultaneity inevitably assumes an uncollapsed four-dimensional subuniverse, not without remarking beforehand that physics has not observers localized in space. What rather can be localized, and engaged into translocative motion whether inertial or accelerated, is the observer's immediate circumstance, covolumetric with certain states of the observer's brain gray [10] – a factor whose present interest resides in that neither observers, nor their meetings or even a single 'event of observation', can be pointlike, or unextended. Neurobiology puts thereby a ceiling on the accuracy with which physics can represent different reference frames by different observers. In computing positions, the observers' extension imposes onto the precision of calculations a certain indeterminacy, usually insignificant. It, nevertheless, may become not negligible when one tries to ascertain the time-like

¹⁰ Evaluating a path integral along different paths one gets different results, so that the elapsed proper time of a twin is less than the other and the latter ages less; references below in the text.

thickness with which special relativity finds itself compelled to describe the present and simultaneity.

The relativistic indeterminacy created in this fashion may be judged small, though it suffices to prevent special relativity from rigorously considering that time dimension does not exist, *i.e.* that the time-like thickness of present must be exactly zero. But we will come later to it. By now let us follow Petkov's and other expositions of the topic in considering three pointlike inertial observers A, B, and C in relative motion whose worldlines (the lines of their entire lives in time) are shown in Fig. 1. Observers A and B meet at event M. The third observer C is represented by a vertical worldline in the figure which means that A is approaching C, whereas B is receding from C.

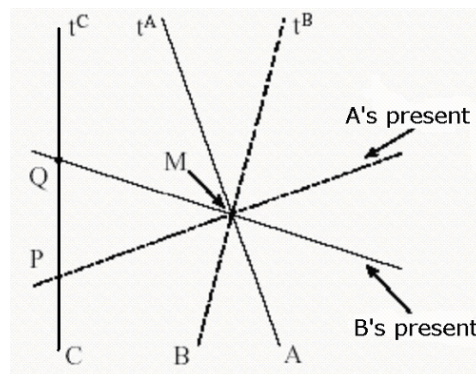


Figure 1: Rietdijk, Putnam and Maxwell called attention onto this setting, here taken from [1]. Three inertial observers A, B, and C are in relative motion. Events M and Q belong to A's present and are therefore real and determinate for A, whereas for B real and determinate are events M and P since they lie in B's present.

Two events P and Q happen with C at different instants of his proper time. The events P and Q are simply the observer C existing at the instants t_{cP} and t_{cQ} of his proper time, respectively, in some places at a distance from both inertial observers A and B. Both events M and P are equally real for B (according to Putnam) or equally determinate for B (according to Rietdijk). Both events M and Q are equally real and determinate for A. Putnam and Rietdijk assumed that the reality and determinateness of an event is observer-independent or *absolute*, concluding that if event Q is real (determinate) for observer A, it should be as real (determinate) for observer B and for observer C as well. Observer C should thus exist *at once* at both instants t_{cP} and t_{cQ} of his proper time since events P and Q (corresponding to the two instants) are equally real.

But such a situation is not possible in the common-sense (pre-relativistic: mammalian, avian, and reptilian) view according to which it is only the present – the three-dimensional subuniverse at the instant 'now' – which exists. This led Rietdijk and Putnam to conclude that relativity of simultaneity, also called failure of simultaneity, *when applied to what exists* (*i.e.*, to realities assumed to include some ones existing at a distance of localized observers), contradicts the presentist view and is possible only in a four-dimensional subuniverse where the histories of the physical objects are entirely realized in their four-dimensional worldtubes, *i.e.* their entire histories in time and space. In such a view the presents of observers A and B

are equally real because they are merely three-dimensional cross-sections of the four-dimensional subuniverse – the subuniverse is uncollapsedly four-dimensional.

4.2. *The effective describability of present situations.* Stein criticized the Rietdijk-Putnam argument, Petkov recaps, "as it incorrectly used the concept of *distant present events* (*i.e.* the concept of the present). Stein pointed out that 'in the theory of relativity the only reasonable notion of *present to a space-time point* is that of the mere identity relation: present to a given point is that point alone – literally *here-now* ' [27, p. 159]." Yet it behooves us to recall that, in order to show that observers need not agree on which events are simultaneous, those observers need to stand in relative motion, a translationality that precludes to occupy a single spacetime point.

Yet Stein's criticism is valid even if, as Petkov points out, it supports the first part of the Rietdijk-Putnam argument – that special relativity shows that there can be no objective distinction between past, present and future, whence presentism contradicts special relativity and is therefore not to be assumed in relativistic descriptions. (In the last section below it is discussed whether this atypical constraint *also* is "noumenally", physically, or ontically appropriate, or it is not). In special relativity the present, *i.e.* the three-dimensional subuniverse at the instant 'now', if at all definable, can be defined only in terms of the pre-relativistic division of events into past, present, and future. Any definition in the style of "present is everything efficient to cause transformative effects" cannot be accommodated in non-dynamic scenarios, such as those constructed by special relativity. Therefore, the present in special relativity is defined as everything that exists *simultaneously* at the present instant.

Whence Stein's argument that one cannot talk about distant present events in the framework of special relativity is a (well-trodden) argument against the effective describability of present situations. As it is notorious, describing instantaneously the situation of distant present events requires a supernatural depiction by a non-localized observer utilizing space as in Newton's image of space as "sensorium of God" – or, rather for a PPPPPP, as the sensorium of an ubiquitous determining *lógos*. Stein's is accordingly an argument on which localized observers might confidently build.

Reason is that, for localized observers, reference to events occurring at a distance demands analyzing the action of signs (semiosis), turning describability inescapably circuitous. As signs should end up detected by the observer's bodily receptors, assisted or not by physical or mechanical interfaces, this seems a biologically-stemmed indirectness, whose bold reminding our imperfection and bodily needs might be taken as offending rigorousness.

4.3. *Semiosis enables describability of present situations.* But, like bodily constraints, too signs suscite fiery passions and huge misunderstandings. In an essay surveying the claim that relations are 'external' to their terms and exploring ontological accounts of this purported externality of relations, Bains [29] observes that an understanding of the ontology of relations allows for a compelling account of the action of signs, *i.e.* how things come to stand for something other than themselves – distant present events, whose consideration is unavoidable when trying to imagine the local perspectives of observers reciprocally engaged in

relativistic-speed motion, as in our present case. Bains [29 Chapter One, "An Even Briefer History of Relations", quoted with permission] puts it so:

Aristotle is interested in the really real, distinguished as the way things are independently of the mind – *extra-animam*. ... The problem with [h]is way of approaching things is that relations between individual substances become metaphysical nuisances. ... as Weinberg notes (1965: 63), very few philosophers seem to have realized why 'relations cannot really be fitted into a substance-accident ontology.' Remember that for Kant categories were things of the mind or mental entities – the subjective forms of understanding – whereas for Aristotle the mind does not impose its own relations on the sensory manifold. ... As might become mind-blowingly evident, neither of these alternatives is adequate in accounting for our experience, or for describing how semiosis (the action of signs) actually works.

... There are two attempts at categorizing the relative in the *Categories*. Aristotle's first attempt is as follows:

Those things are called relative which, being either said to be *of* something else or *related to* something else, are explained by reference to that other thing.¹¹

Now Aristotle recognizes that this definition contained some ambiguity as to whether relation constituted a distinct category of being within the substance-accident scheme, and decides that he has to modify it:

Indeed, if our definition of that which is relative was complete, it is very difficult, if not impossible, to prove that no substance is relative. If, however, our definition was not complete, if those things are only properly called relative in the case of which relation to an external object is a necessary condition of existence, perhaps some explanation of the dilemma may be found.

The former definition does indeed apply to all relatives, but the fact that a thing is *explained* with reference to something else does not make it *essentially* relative.¹²

As Deely astutely notes (1974: 867), 'this distinction between what must be *explained* by reference to something without having itself to be a relation, and what is *essentially* a reference to something other than that on which it is founded or based, is the first recorded glimpse of what was to become the Latin distinction within the order of relation between what is relative *secundum dici* [according to the way it must be expressed in discourse] and what is relative *secundum esse* [according to the way it has being].' Articulating this distinction and showing how it is relevant to semiosis and an order of being – the ontological status of the being of relation – that is neither substantial nor accidental, neither subjective nor objective, but rather preceding any categorial schema, is what this story is about: i.e. the being *of*

¹¹ Aristotle, *Categories*, ch. 7, 6a36-39. In *The Basic works of Aristotle*, ed. Richard Mckeon, trans. E. M. Edghill (NY: Random House, 1941), p. 17 [Bains' footnote].

¹² *Categories*, ch. 7, 8a28-34. Edghill trans., loc. cit., p. 22 [Bains' footnote].

the middle, distinct from the terms of the relation; the exteriority of relations to their terms; or an event of interbeing.

Now we have reached a threshold. This distinction between *relatio secundum dici* and *relatio secundum esse* was discussed throughout the medieval period ... The difficulty in grasping this distinction between relative terms and the relations themselves is twofold. First, apart from Poincot's *Tractatus de Signis* (first published in 1632), its proper thematic articulation has almost totally disappeared from our conceptual landscape since the time of William of Ockham and the rise of nominalism around 1350 which denied an ontological status to relations independently of their terms. Second, Aristotle used the expression *to pros ti* to refer not only to relations themselves, but to the things which *have* relations. This contributed to the only slowly-dawning (and soon to fade) awareness that every 'thing,' or term, is 'relative' in two different ways: Firstly, it can only be understood *with reference to* other things (*relatio secundum dici*); secondly, there are the ontological *relations* that the 'thing' is actually involved in (*relatio secundum esse*). Subtle perhaps ... Terminology [is as follows:]

1. *Relatio secundum dici* (Relation according to the way it must be expressed in discourse).
2. *Relatio secundum esse* (Relation according to the way it has being).

The main point [was] *To be able to really be a relation*, although existentially dependent on some relative foundation, *or to only be something that is relative to other things*, but without there actually being a relation 'external' to its terms: that was the question. ... Ockham accepts order and unity in the universe, objective similarity, causal connection; but he insists that this unity, causality, etc., consists only in the terms themselves, and is conceived by relational concepts in the mind. This is the view that Kant will effectively radicalize: it is by a property of our mind, the form of outer sense, that we represent the shape, magnitude, and relation of things to one another. ... It was the genius of Russell, in effect, to seek in the reality of relation a way through the mind-dependent structures of discourse to the mind-independent reality of things. It was the genius of [Aquinas], after all those years, to have given rise to a tradition that has within its resources the wherewithal to uncover the very path whose existence Russell suspected but failed to uncover. This discovery is not something to crow over. Only one man – John Poincot – ... seems ever to have suspected, as Russell did, that the path was there (Deely: 1975: 306)."

4.4. *Three-dimensional presentism as an effect of discourse.* Now Stein, Rietdijk, Putnam, Maxwell, and Petkov recognize that presentism contradicts special relativity and therefore one cannot talk about distant present events in special relativity. Yet one wishes doing it; moreover, inescapably one must do it in order to show that observers need not agree on which events are simultaneous. To this purpose observers must be in relative motion, preventing them from being non-spatial or occupying a single spacetime point.

How to discount unavoidable distance? Should the struggle for more ken be a struggle against time? Is there a cost, perchance, by defraying which one could

refer to distant present events? Is this reference possible only by introducing Minkowski spacetime – or rather, the block-universe outlook which it conveys – as an inescapable condition? Owing to this relationship with the subuniverse to the way it has being, *secundum esse*, or either to the way it must be expressed in discourse, *secundum dici*?

For, special relativity's descriptions are related to the means for observers to exchange kinetic (namely, not dynamic) states and, in so doing, positions from which to establish relationships with other realities such as rods, interstellar trains, and force carriers whose physical action, no matter how long a travel obtrudes, must be instantaneously and locally delivered in order to cause a change. Describability of distant present events thus depends on elaborate semioses, whose Piagetian development in every individual observer was sketched before. It brings always a past element which, among other constraints coming from the structures of discourse, must be included in relativistic portrayals.

So, Stein's criticism is effective against the fully accurate describability of the three-dimensional subuniverse, inasmuch as a three-dimensional subuniverse only consists of distant present events (everything that exists simultaneously at the instant 'now'). Stein's criticism is tantamount to demand, very justifiedly indeed, a rigorous analysis of semiosis; an analysis which too often was missing, *e.g.*, in accounts of the twin 'paradox' and other 'failures' of simultaneity. But – Petkov avows – unfortunately Stein did not address the most fundamental question raised by the unavoidableness with which relativity of simultaneity *inevitably* involves and requires an uncollapsed four-dimensional subuniverse. What is the dimensionality of the macrosubuniverse according to special relativity? Had he done that he would have had three options:

- accept the conclusion of Rietdijk and Putnam that we live in a four-dimensional block universe, the things being constituted by unremitting temporal parts; or
- accept the conclusion of Rietdijk and Putnam but investigating if
 1. the four-dimensional span is greater than what causation demands, so 'hanging' all transformational courses in our subuniverse;
 2. or, the four-dimensional span is smaller than what causation demands, so preventing any transformation from coming to be in our subuniverse;
 3. or, the four-dimensional span is neither more nor less of what causation demands, so allowing in our subuniverse transformational courses in causal sequence;
 4. or efficient causation does not exist at all, so merging with the first option (above) in forcing any (thus, apparent) sequence in our subuniverse to really exist all at once, given completely or 'in block';
- or, as his third option, regard the event "here-now" as the only real – and accurately describable – one.

4.5. *The menace of event solipsism: strength of the subjective flank.* The latter option, of course, does not appear realistic if one thinks that such a view clearly amounts to event solipsism – for every observer the extramental subuniverse would be reduced to a single event (the event "here-now") and as a

result too the intramental complexity would be so reduced (since the surroundings' complexity was found requisite for interactive development of the mental world). Yet the supposition fails both on its subjective and objective flanks. Let us comment on the two.

As about the subjective flank, everyone's phenomenal experience, by its being multifaceted and compounded rather than undividedly-vented or 'block mentality', contradicts this reduction to a single event and, too, any claim of its ultimacy. For, "It is proper of the soul to have a *lógos* that builds up itself" (Heraclitus, fragment 115), and which one of one's mental contents would be ultimate? The so-settled issue is not new. It is linked to the answer, of fundamental momentousness in the Western History of Ideas, culturally responding to Gorgias' apory¹³ by making *transzendentale* the *synthetische Einheit der Apperzeption*, and its evolution was historically reviewed in two important and interrelated syntheses by Rodolfo Mondolfo [30,31] and Section 2.8.2, "Concepts of the unifying function of experiencing", in [3, pp. 686-702]. Quoting from the latter (square brackets added):

"Aristotle's research-design, *uncolliding with Plato's technical affirmation of the spiritual psyché as a decisive and imprescindible condition of every sapience* (or: physical measurement), focuses (in his fundamental Chapter VII of *Peri aistheéseos kai aistheetoôn*, 447 - 449) on *the possibility of sensing two things in one same and psychologically indivisible moment of time by means of one unique sensation*.

¹³ In [3], p. 686, this apory is commented ad follows: "Gorgias' splitting, the Danæan gift. The starting point in the Western thought, for these researches on the unifying function of the experiencing, was the extreme form reached by the sensualist phenomenism in Gorgias (-Vth century). Along with reducing every possible sapience to sensation, he added that it is not communicable (the noematic *Unübertragbarkeit* pointed by Prof. [Max] Born: the one due to structurelessness, not that due to cadacualtez); not only from one experiencing to other (e. g., from yours to ours) but, also, even from each set of sense's sentiences (in any of their thetic modes) to any simultaneous other. So, the personal experiencing inside any single organism was postulated as *multiple*, because of the separation of the different sensations into stanch compartments, mutually incommunicable. Like the blindness for the *noetic* incommunicability of cadacualtic availabilities, this atomization is typical of every sensualist phenomenism and a consequence of it, as often evinced, for example, in the French sensualism of the XVIIIth century (with Diderot, and specially with Condillac) and parallel Eastern developments. It offered itself to Plato's especial reflection, as in *Theaetetus* 184 b *sq.*, where he refined his critique of sensualist empiricism. There, Plato denied and rejected that each sense modality could enjoy by itself a direct and exclusive apprehensional grasping of its own sensations.

To clarify the need of a *unifying conspection* ("*binding*"), Plato forwarded the comparison with the Danæan gift, that Prof. Jakob much often recalled when recounting the history of the understanding of the sensations' conspectivity [and, as well, in other context, *i.e.* regarding the annexation of subjective intonations to the physiological relaxation of the gray's system of reverberative stationarities: a "*regalo dáneo*", he remarked, since so few joys bring about so many afflictions; see "What is a person?", in [3] § 2.13.4.1, "*The definition of persons*"]. Inside the wooden horse of Troy, each Danæan warrior stayed distinct and separated. But the functional *purpose*, or systemic *finality*, of both Greek warriors and separated animal senses, requires a mutual unifying binding: one adunating agencies previously apart. Bare sharing a receptacle is not good enough. Then the [PPPPPP's] syncretic myth inspired a critique, of the aptitude of sense sentiences to constitute a psychism (*Theæt.* 184 bc), even if this psychism was sort of fungible stuff. Are senses sensible, or instead mere organs, reporting to a reality more valuable for the myth's values?"

This crucial query had been already set forth by the Pythagoreans. In their casting, it befitted the perception of musical accords, whose compounding 'notes' (the Pythagoreans affirmed) are discerned because they are not perceived simultaneously, but by intermixing betwixt them certain unperceived intervals, whose intermediate situational transformations are insensible on account of their brevity. A naive remark, brimming of baleful repercussions.

During these sub-acuity intervals, as Aristotle ordered to write, "one ought not to know if oneself exists, if sees and if feels": a horrible prospect when one's reduction to one's grasp is in the loom ([3] § 2.5.1). Aristotle concluded that, inside one sole sense, it is *not* feasible to feel two things at once with a unique sensation. So he told apart *two unities*, that of sensation (*incompatible with distinguishing component impressions*) and that of cognoscitive synthesis (*attained by comparing and discerning two impressions simultaneously produced in one sense*).

In this way, Aristotle achieved a chance to reject the unperceived intervals, acquiescing in the syncretic myth [of P P P P P P], on the ground that the unperceived sub-acuity intervals could be likewise postulated not inside each separate sense, but to sensations of different senses. In such eventuality, it could be also held in like fashion that it only 'seems' to us seeing and hearing jointly, because the intermediate intervals elude us. This would straightforwardly usher into conceiving noesis as a flashing physical phenomenon. But such a verdict was culturally untenable, owing to having supposed past and future not *really* different from present, therefore imagining that a multiplicity of non-simultaneous flashes could get mutually lost. In fact, as anticipated *supra*, any time-'fragmentation' of the biographies, insofar as self-addressable, by no means precludes the unitary constitution of *psychai*, since the subuniverse shows to be temporally thin on the duration of its actuality and its situations either include, or exclude, such *unique* self-addressable fragment. And, for adversaries of elapsing productive time, besides being culturally untenable, such a verdict was privately deleterious.

Thus, obedient to the myth, Aristotle objected that *'this is not true, and it can neither be any insensible time nor escape our grasping, but it is natural that everything be sensed.'* " [3, pp. 689-690].

4.6. *The menace of event solipsism: strength of the extramental flank.* As for the second, extramental flank, event solipsism (reduction of the subuniverse to a single ascertainable event or non-spatial "here-now") by no means stands for a real possibility inasmuch as every observer observes extended over a volumetric parcel of nature, as summarized in [3, 32]. This extramental parcel is not an inespacial point; to call up familiar instances, it rather is the volume segment of nature overlapping our encephalic gray. Structures in this volume accomplish the physiological dissimilations which became evolutionarily selected because, in turn, they efficiently originate mental differentiations as causal reactions [6]. By no means a sole ascertainable event, such a parcel is thus the fragment or section of nature whose biophysically-dissimilated states, spatially extended, do causally interact with the observer who is a single existentiality. The states of this not-pointlike parcel of nature perform the cerebral dissimilation of the circumstanced

mind's structural contents, differentiating in this observer existentiality also a plurality of fresh sensations and enacting the aforementioned behavior through which this observer probes the surroundings and, so, attains the intellectual development required to carry out relativistic observations, measurements, and constructions. As a result, for every relativistic observer the spatial subuniverse existing once at a time, far from being forcibly reduced to a single event (a "here-now" unorganizable eventuation of cognoscibility), can become semiotically referable at a distance yet with adaptive accuracy, through the localized observer's numerous differentiations ('mental contents') acquired in the course of his intellectual development. This semiosis at a distance is what the relativistic constructions of simultaneously unmeasurable positions amount to.

For this localized observer, ascertaining the genuine simultaneity of any pair of observed events, namely whether or not is he facing a simultaneity that as such admits or may exhibit causal efficiency, does certainly bring troubles, because the said semiosis at a distance was not biologically selected for covering all the cases; astronomical observations provide good illustration. The relativity of simultaneity finds in celestial mechanics, precisely, an important field demanding the use of relativistic descriptions, whereas as regards stellar navigation biological adaptations remain utterly nonchalant. But what matters for our discussion is that, had Stein addressed the issue of what is the dimensionality of the subuniverse according to special relativity, he had not been compelled to reject presentisms (neither the time-denying nor the time-acknowledging ones) owing to assuming that presentism entails an untenable reduction of observer and observation to a non-distanceable (non-spatial), "here-now" single event. Neither organism-regulating existentialities (*psychai*) nor the subuniverse (*i.e.* each portion of reality evolving from a single big-bang) are bounded to stay undifferentiated, as a single initial event (eclosion to a given circumstance, for every organism-regulating existentiality; big-bang, for subuniverses). Quite the reverse, after their respective eclosion event they differentiate themselves following causal courses: respectively, into mental worlds, and into astrophysical-biological cosmologies.

4.7. Odds of accurately describing distant present events. Therefore, the (non-rigorous, as immediately commented) statement of fact, that measurements should always be locally performed and cannot be carried out at a distance, does not entail that separative distances must be deemed unreal and, for that reason, the dimensions of spatiality ought to be reduced to zero-dimensionality ('point universe'), as if semiosis at a distance not existed. In fact, with a sole (neurobiological) exception whose discussion is of no use here (see ref. [6]), a distance negligible for pragmatics always interposes between measured and measurer, and when *e.g.* one ascertains, with considerable imprecision, some assumed spatial relationships of galaxies or metagalaxies, one simply increases such a distance in a way that it no longer remains negligible – and accompanies measurements with estimates of error and hermeneutical instructions.

Science proceeds this way far and wide. Thus one comes to primarily deal with real extramental things, for example real cups, out of one's mind and at a distance there on some table, or events farther away in space, though upon introspection one might also consider one's 'concept' of them. Thus, as the natural sciences find knowers and knowledges in nature, the proper object of every mind's intellection is the causal composibilities of the sensed outer reality that, in their

(extramental) reactions to the mind's causally efficacious, spontaneous probing, generated the generalizing retexturing underwent and retained by the mind's knowable build-up. It distinguishes intellection from sensation, though this distinction is by no means absolute. In other words, once the question "What is the dimensionality of the subuniverse?" is asked, one could not reject presentism by assuming that only the detached event "here-now" is real and it would mean that for every observer the subuniverse would be zero-dimensional, *i.e.* just one event. As space is pervasive, distance always obtrude; and as efficient causality works, at least some observers and some subuniverses differentiate into a plurality of events and mental contents.

Before leaving this topic, it should be stressed that it amounts to a contradiction in terms to say that the subuniverse is four-dimensional, but for every observer only the event "here-now" is real. A block is a block. If the subuniverse is four-dimensional all *its* events (which only could be really plural in number on condition that the fourth dimension is collapsed so as to allow efficient causation to produce change) are equally real ('block universe'); otherwise, it would not be four-dimensional. The real issue is, if those equally real events are entirely given beforehand, maybe just being observed – or presenting themselves to observation – sequentially; or, if rather they can engage themselves into real transformative courses, which may seem to course in preexisting time but in fact do create such a course not by using a navigable timespan external to the present but in the innerly transforming, preexisting, time-like thin reality, making way like as running long *distance* in a threadmill, without need of availing of an uncollapsed, perduring, navigable time dimension: *se hace camino al andar* (way is made moving). This latter possibility demands both the reality of frame-invariant efficient causation and its dovetailing with such a fourth-dimension's span. (As already intimated, if the fourth dimension is collapsed down to the minimal timespan required for efficient causation, no transformation event may occur contained within such a time-like thickness¹⁴; if, in contrast, the universe is uncollapsedly four-dimensional, it may contain a multiplicity of events but not their transformations; in both cases, the entirety of occurrences cancels its non-being at once, preventing elapsing, edacious time – *the devourer of things*, as Ovid said – and objective becoming from existing.)

4.8. *No resource to 'potency' – or, the specter of steéresis.* This, as Petkov points out, shows that in spacetime it is impossible to have an event, representing the event "here-now", which is 'more real' than the other events. Therein realness is homogeneously distributed, making such block universe a block of being, tantamount to a being in block. Interestingly, this ontic homogeneity does not fail when the fourth dimension gets collapsed or anyway restricted in its span and, as it meets some features of efficient action, the block gets pulverized into a really changing plurality of interacting entities. In that plurality it does not matter that one event be so much immediate to an observer that it directly causes in such observer known reactions (sensations: *e.g.*, certain field state variation within the brain), whereas other events stand so much remote (*e.g.*, a possible interaction between quasars) that their positions should be ascertained through this observer's

¹⁴ Events are enacted at the boundary with non-being which has not exhausted causal efficiency; not at the opposite one.

intellectual development and its application to semiosis, *i.e.* through a complex construal of nature based on the evolutionary natural selection of proper neurobiological analyzers plus the mind-texturing accumulation of personal probings plus their ensuing collation and the social decanting of the resulting experience [33]. Whether immediate or, instead, remote to the observer, all the events recognized to be existing in a fourth dimension-endowed macrouniverse ought to be deemed on an equal footing as regards their reality. In a four-dimensional subuniverse whether with uncollapsed or with causation-matching collapsed fourth dimension, objective flow of time and objective becoming are therefore impossible if they implied that there are events which are 'more real' than the other spacetime events.

In such circumstances, event P could not be 'potential' while event Q is real, or viceversa. Far from being a predicate or a simulatable appearance, 'to be' is an all-or-none issue – an enaction outwardly manifested as an invariant conservation, following the aforementioned Plato's hint and Emmy Noether's theorem [32]. As it is notorious since those remarks by Plato, causal efficiency involves frame invariance, *i.e.*, no perspective could be found in which the causal relationship of a course of physical events would appear uncalled for, because *both* transforming preexisting beings and cancelling their non-existence are efficient enactments: far from being a predicate or a logical or discursive capacity, 'to be' is a causal enactment.

So ruled out possibility (the '*being possible*', potency) to account for observer C's living both A's and B's diverse simultaneities, ruling out probability is even plainer, even though the complications brought by notions like 'molecular disorder' to several sectors of physics (such as plasm turbulence, viscosity, or thermal conductivity) have been huge. But special relativity's constructions are not statistical. Were they so, potency or Aristotelian *steéresis*, in the form of probabilities, could be used as a shortwriting for what mechanics provides on individual cases, like as a hundred and ten years ago Boltzmann recognized for gas theory. But special relativity is an interconversion procedure which, being forced to deal with particular configurations in order to make predictions which can become experimentally tested, cannot eschew facing up to what individually exists or, by yielding statistical results, accommodate some fiction of potential being. For this reason, *i.e.* the real distinction between existence and characterization which precludes exhausting 'to be' into any combination of proper predications, none of its described events can be 'more real' than the other events, so that the question of the dimensionality of the subuniverse clearly precedes the questions of time flow and becoming – and, as Petkov claims, should be resolved first.

Still another reason, also in Petkov's view. Stein could not either argue that existence should be relative, *i.e.* frame- or observer-dependent – a condition which would preserve the zero-intervalic-thickness, three-dimensionality of the subuniverse and would allow two observers in relative motion to have different presents, *i.e.* different three-dimensional subuniverses – because this would mean that he would be *again using* the concept of distant present events applied to each observer.

4.9. The strength of Stein's argument. In such a way, Petkov points out that Stein's criticism of the Rietdijk-Putnam argument not only does not disprove it but effectively constitutes another argument for the block universe view as the sole

worldview compatible from relativity. Stein's criticism is tantamount to state that a science of physics acknowledging the relativity or failure of simultaneity cannot declare the macroscopic subuniverse sheerly three-dimensional, since a three-dimensional subuniverse is defined in terms of the pre-relativistic division of events.

Petkov remarks that by pointing out the meaninglessness of that concept in special relativity Stein effectively demonstrated the contradiction between the presentist (sheerly three-dimensionalist) view and relativity of simultaneity. This meant that it is the four-dimensionalist view that is in agreement with relativity – although, as discussed below, one can not yet conclude thereof that the only option which remains is an uncollapsedly four-dimensional subuniverse with a 'time' akin enough to space (of course not identical: while in space we can only measure ratios but reproductably, in measuring time we directly ascertain the causal production of new situations but nonreproductably, as it is pointed up by the disparity of invariants and transformations in their respective geometries) to let that 'temporal parts' perdure differently localized and observers might get 'translocatable' among them as well as in space.

Weingard [34], like Stein, pointed out that Putnam's argument is wrong because it is based on the pre-relativistic concept of distant present events. Petkov insists that both objections are different but they boil down to the same point – that the pre-relativistic (presentist) division of events into past, present and future ones makes no sense in special relativity. Despite being formulated in terms of pre-relativistic concepts the Rietdijk-Putnam argument remains perfectly valid [35] as it points out the unbreakable ties of special relativity and four-dimensionality.

5 Only the Four-dimensionalist View is Compatible with Special Relativity

5.1. Probing a generalized version of the Rietdijk-Putnam argument. Petkov [1, p. 8] feels that the Rietdijk-Putnam-Maxwell argument can be easily generalized if the question of the *dimensionality* of the macroworld according to special relativity is explicitly addressed. In so doing he finishes by showing that special relativity is valid only in an uncollapsedly four-dimensional subuniverse represented by Minkowski spacetime (and in its time-collapsed segments only inasmuch they are referred to by it), but starts to discuss that question by pointing out to the pre-relativistic (presentist) subuniverse that is sheerly three-dimensional – the present of zero intervalic thickness visualizable by thinning to nil the plane in Fig. 2. Then he faces two ways to demonstrate the impact of special relativity on this panorama.

- On the one hand, one can first point out that the macroworld cannot be sheerly three-dimensional and still be in line with a failure of simultaneity deemed not to depend either on observers' features or on the signals' delay. Reason is, that such a macroworld is defined in terms of a pre-relativistic division of events into past, present, and future (Fig. 2) which entails unmodifiability of the 'earlier-later' relationship. The relativity of simultaneity, when applied to what exists, thus contradicts sheer three-dimensionality, being only possible in a four-dimensional subuniverse where the histories of the physical objects either (a) are sequentially deployed by an efficient causation whose discrete modules of enaction match the residual

time-like span of a collapsed fourth dimension, or (b) are entirely realized ("given at once") in the four-dimensional worldtubes stacking their "temporal parts". But efficient causation is not included in special relativity scenarios. Therefore, the debate over the dimensionality of the subuniverse is resolved in favor of the four-dimensionalist view assuming a space-akin time dimension uncollapsed - and things existing at all moments of their histories. This is the conclusion that follows from Stein's argument against the Rietdijk-Putnam argument.

- Petkov's second approach to determining the dimensionality of the subuniverse according to relativity is precisely the generalization of the Rietdijk-Putnam argument. One starts with the mentioned pre-relativistic view of the subuniverse. Then it inescapably follows that having different sets of simultaneous events two observers in relative motion have different three-dimensional subuniverses of zero intervalic thickness, *i.e.* different presents. On this generalization, rather than special relativity, it is such a null time-like thickness what prevents accommodating efficient causation, thereby eschewing causal quandaries.

In this scenario, inasmuch as existence is absolute, *i.e.* inasmuch as every cancellation of non-being is a causal enactment which, as such, does not admit anamorphosis (simulation or physical mimesis, *cf.* [3], *passim*), in order that relativity of simultaneity be possible it follows that either the different subsets of simultaneous events should reflect a relation *secundum dici*, or the subuniverse must be uncollapsedly four-dimensional: the two observers will have different sheerly three-dimensional cross-sections of the four-dimensional subuniverse, which cross-sections they will regard as their presents. But, again, if we assumed that the macroworld is sheerly three-dimensional, two observers in relative motion would have a common three-dimensional subuniverse and therefore a common set of simultaneous events - which means that not only existence is absolute but also simultaneity would be absolute, in contradiction with special relativity.

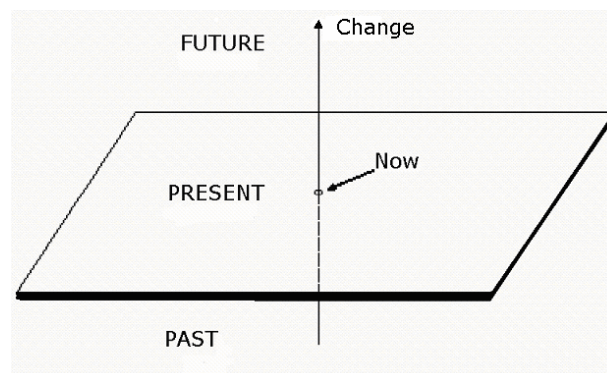


Figure 2: Nature's time-like thickness; the main feature here is the thickness of the 'plane' of present. On both presentist views, *i.e.* the fourth-dimension-denying and the fourth-dimension-acknowledging ones, it is only the present - the three-dimensional subuniverse at the instant 'now' - that exists. For the first sort (time-denying), the plane's thickness is zero (the thickness of any other simultaneity plane is zero, too) and the sole efficient causation occurs among Ideas (Platonisms) or ideas (subjectivisms). For the other sort of presentism (time-acknowledging), the plane's thickness is interval-like and related to fundamental physics, whose causal efficiency enacts time courses. These course as transformations of the extant being and not on a time dimension, which indeed stays at this scenario but has collapsed into the time-like thickness of its present. Future and past sequences, thus, do not exist.

In forwarding the generalized version of the Rietdijk-Putnam argument, Petkov observes [1, p. 9] that the kinematic relativistic effects (with the exception of the so called twin 'paradox') only can be formulated in terms of the pre-relativistic division of events if the (absolute) *existence* of the objects involved in these effects is explicitly taken into account. And indeed as we have seen relativity of simultaneity makes sense only in terms of the non-relativistic concept of absolutely present events when we ask what *exists* simultaneously. If one objects that the question "What exists simultaneously?" does not appear to be well defined because of the unavoidable spatial distance that brings into every measurement the need of semiosis, it will be shown below that the purely kinematic length contraction effect makes sense only in terms of the pre-relativistic concept of present events of null time-like thickness. Why? Because special relativity draws only kinematic situations. Kinematics does not consider efficient causation, which rather form the basis for dynamics and is excluded from both time-denying presentisms and block-universe special relativity scenarios.

5.2. Special relativity's ties with the uncollapsed four-dimensionalist view. For that reason, when the issue of the dimensionality of the subuniverse according to special relativity is explicitly addressed, it does appear that according to special relativity there is no alternative to the uncollapsed four-dimensionalist view. Special relativity, a kinematic and not a dynamic contrivance, is telling us that the world must be depicted this way or no relativistic depiction is possible at all.

Rather, in the collapsed four-dimensional presentisms only one situation at a time, namely the privileged, causally efficient situation whose transformational sequences are frame-invariant and in several languages is called 'actuality', could be simultaneously present; not a plurality of successive situations each of which depends on its observer's motions. This is best seen if one tried to assume that according to the 'failure' of simultaneity the macroworld is three-dimensional. Then not only relativity of simultaneity but all kinematic relativistic effects would be impossible [35, 36, 37]. Petkov remarks that this is immediately evident for the cases of length contraction and time dilation, since these effects are merely manifestations of relativity of simultaneity – a relativity unretainable while simultaneity is absolute.

5.3. Proof one: discussing the length contraction effect. Therefore, there is no kinematic way of gaining the two, simultaneity's relativity as well as absoluteness, as children do in choosing at once both irreconcilable things between which they should retain only one (*katà tèn tòn paídoon eujeén*: Plato's *Sophist* 249 d 2/3, quoted in [3] § 1.3.28, *in fine*). Simultaneity should either fail or be absolute. To demonstrate the impossibility of the kinematic relativistic effects in the framework of the presentist three-dimensionalist view, Petkov considers for example the length contraction effect, as two observers A and B in relative motion meet at event M.

Traditionally, observers in relativity have been characterized fairly sketchily, but while making headway on many avenues science remains a single endeavor. Thus listing some key requirements imposed by other academic disciplines focuses our fancy, befits our discussion, and steers clear of ontological assumptions that might be subreptitiously introduced by concealed denials of space or time – such as

speaking of pointlike observers, pointlike meetings, pointlike events of observation, instantaneous changes, and instantaneous detections. The meeting observers, thus, are non-infinite: they only can observe some events of variation occurring in their own ontological buildup and cannot observe any event taking place elsewhere, whether in extramentality or in the buildup of other observers [6, 32]. Therefore, their meeting is not a gnoseological fusion: each of them keeps observing only the own buildup. This buildup is interactively accessible from extramentality not by way of a sizeless inespacial point, but by way of a neuroactivity occupying certain sizeable volume. The observers' meeting is not epistemological fusion, either: it does not exceptuate them from enacting shareable procedures aimed to ascertaining if, through dependable semiosis, some of the events which they separately detect in themselves are indeed referable to one and the same extramental occurrence.

Petkov represents these observers by their worldlines as shown in Fig. 3. A rod at rest in A's reference frame is represented by its worldtube. But here it seems necessary to do exactly the reverse of what we did a moment ago when pointing the relevant, unnegligeable physical features of observers, signals, and meeting. As the Babylonian observed that when someone points to the moon others may just look at the finger, in order to stay away from supposing that also a rod's non-geometrical or physical properties hold here any relevance whatsoever it is important to remark that in relativity the rod demarcates or merely represents a certain small piece of A's travel path.

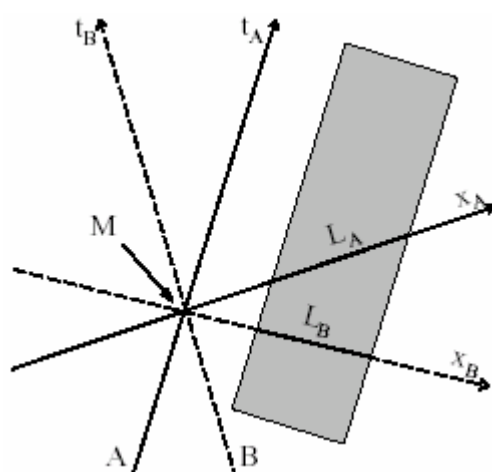


Figure 3 as posted by Petkov [1, p. 10]: A rod represented by its worldtube is at rest in observer A's reference frame. The rod extends over a small piece of the travel path. Thus it may display whatever shape; the discussed effects affect the physical rod *only inasmuch as it has extension in the relative motion's direction*, which the simplified diagram cannot make apparent.

At event M the two observers determine the length of the rod in their reference frames. For B the rod, *i.e.* the said small segment of A's travel path, is shorter length $L_B < L_A$. The exact relation between the two lengths is obtained by the Lorentz transformations, which do show that $L_B < L_A$. As seen in Fig. 3 the contraction of the rod or segment of A's travel path is only possible either if (a) the worldtube of the rod or segment of A's path is a real four-dimensional object or (b) if the observers' speed affect their respective semioses in the context of a fourth

dimension collapsed in a fashion that matches the causal span. This means that either

- the rod or segment of A's travel path exists equally at all instants of its history, or
- its two tips at one and the same instant t_0 emit signals with the same state of uniform motion on whose arrival ('observation') such signals are efficient to immediately cause, in the observer circumstanced to the moving positions setting up the *four-dimensional trajectory* B, the time-insuming process of measurement of a difference which is semiotically referrable – in the context of some description of nature that is enough adequate or epistemologically sufficiently accurate (*i.e.*, not hallucinatory) and has been developmentally prearranged in the observer's buildup – to the space length that at t_0 has been separating the two signal-emission events.

Petkov observes that the instantaneous three-dimensional spaces of A and B intersect the worldtube of the rod at two different places and B's cross-section is smaller than A's cross-section. But the descriptions of special relativity, as it only poses sheerly kinematic scenarios, cannot involve causal action – and of course special relativity has not depicted with any detail its observers positioned in nature, not to mention their causality and absolute motions involved in probing the surroundings and, thus, building the menu of mental operations to be developmentally prearranged in the observer's buildup for apperceiving sensations and penetrating nature's causal works. If according to special relativity the rod's worldtube were not a real four-dimensional object, *i.e.* if *also* according to special relativity the rod or segment of A's travel path existed only at its present instant and therefore were a three-dimensional object (say, A's rod which is represented by the cross-section L_A), no length contraction would be possible in special relativity – A's rod of length L_A should be described as existing for B as well and B in turn should be depicted as measuring the same rod with the same length L_A . Different relativistic describers should denote the same denotata.

If also according to special relativity the rod existed only at its present instant, which would mean that such segment of A's travel path is depicted as an ontologically three-dimensional object (maybe retaining its identity as a three-dimensional object in successive times), it would not exist entirely given in its past and future – namely, as a segment of a *travel*. Therefore, B's cross-section of length L_B would lie in the rod's past and would not exist in the relativistic description. Neither A nor B could be presented as intersecting it; intersection requires worldtubes.

Uncollapsed, navigable, space-akin four-dimensionality is therefore what Kant would have called a condition of possibility: a requisite for relativity to depict that which observations encounter. As we shall see, this is why time is frame-dependent in relativity, in whose descriptions the future is determinate; relativity harbors no alternative to the block universe view.

5.4. Each observer measures different three-dimensional objects. Petkov remarks that, as it seems, "little attention has been paid to the fact that A and B do not measure the same three-dimensional rod". The rod or segment of A's travel path which B measures is a *different* three-dimensional object. This occurs as well in subuniverses in which causation matches the residual span of a collapsed time-

dimension, as in the scenarios representing subuniverses where such a fourth dimension remains uncollapsed.

Every observer ascertains if his or her own mental situation signals two extramental event (the two tips of the rod) occurring in distant space. Measuring spatial positions always involves semiosis, as we saw. Semioses are different for every observer: each is a separate act, enacted by a separate observing buildup, aiming to ascertain the possible extramental reference, of four different events sensed as the receptions of a pair of signals, to the rod's tips that supposedly emitted these signals in an instant t_0 which already is necessarily past, *i.e.* an instant which then left occasion to further intervening causal transformations, always local. This is clearly seen in Fig. 3 – at event M both A and B know that the rod exists 'for' each of them, but in special relativity's kinematic scenarios "this is only possible if there are two different three-dimensional cross-sections of the rod's worldtube, *i.e.* two different three-dimensional rods." [1, p. 11]. Not only in quantum physics, therefore, but also in special relativity what is observed depends in part on the observer.

Same conclusion follows directly from relativity of simultaneity. The different parts of the rod or segment of A's travel path spatially *extended* over the sole three dimensions available constitute a set of events which exist *simultaneously* for A. As B has a different set of simultaneous events (the events constituting the worldtube's cross-section L_B in the relativity's representation) it unavoidably follows that B measures a different three-dimensional rod or segment of A's travel path. In order that this be possible according to special relativity the rod's worldtube must be a *real* four-dimensional object. What does '*real*' mean here?

'*Real*' means that, when we say that according to special relativity A and B measure the same rod or segment of A's travel we refer to the worldtube of the rod or segment of A's travel path, but the observers regard *different* three-dimensional cross-section of the rod's worldtube as their rod or segment of A's travel, which means that they do measure *different* three-dimensional rods or segments of A's travel. Thus worldtubes are not only convenient graphical representations, but also extramental denotata in which observers can refer to different four-dimensional segments or 'slices'. As mentioned, measurement is a semiotic referral and its denotatum in each case is 'for' each of them: as Bains evoked from Aristotle, an instance of something *pròs ti*.

5.5. Pervasive misconstruction of local contraction. Petkov mentions that the fact, that B measures a different three-dimensional rod, appears to rule out any explanation of the length contraction that involves *deforming* the rod or segment of A's travel path, *i.e.* any deformation efficiently caused by forces acting on the rod's or segment of path's 'atoms', "along the lines of the original Lorentz-FitzGerald proposal and what Bell [38] called 'Lorentzian pedagogy' (see also [39])." So the Babylonian caveat reveals to be still sound. The reason is that the deformation (or dynamical) explanation of the length contraction implies that A and B measure the *same* three-dimensional rod or segment of travel, whereas relativity of simultaneity requires that A and B measure *different* three-dimensional rods or segments of travel – different denotata.

It is useless to argument against a local contraction of present material rods, of course. While the misreading is rife (like the attribution of the twin pseudo-

paradox to the 'constricting' effect of acceleration), in fighting it one feels sort of don Quixote beating windmills. According to special relativity the local observer (*i.e.*, one saddling stationary the rod or segment of travel path) observes no change either in local space or along locally-measured intervals. Her 'rod', were the segment of travel path signaled by the *present presence* of some material, does not shrink and ebb under her legs. But the pervasiveness of this common mistake and the 'Lorentzian pedagogy' compels to accost it. Perhaps the most convincing argument that the 'Deformative explanation' of the length contraction is wrong, however, is that this explanation cannot account for the contraction of a material rod-pervading and rod-enveloping local space itself, where no macroscopic displaceable determinations nor specific forces exist that can cause its deformation. Yet the 'rod' or segment of A's travel path contracts. The muon experiment [40], *e.g.*, cannot be explained if it is assumed that in relativistic scenarios space does not contract [41], nor the current developments a propos the evolution of the bodily system that furnishes minds with sensory contents [6, 42] and the neurobiophysical research on the observers' localization [6, 10, 32].

Length contraction and parallel time dilation can be formulated *only in terms of the semioses-involving concept of distant present events* (*i.e.* the concept of everything that exists simultaneously at the instant 'now': the unmeasurable present) even if – as might be seen on some non-inertial scenarios – the intervening distance is fairly short. The latter occur whenever the kinematic situation can be described as a strongly accelerated motion of relativistic magnitude (even a slight one) setting up what must be classically conceived as circular trajectories of microphysical radius (*e.g.* in the classical scenarios set by the fine structure constant α for the electron in a hydrogen atom), from which trajectories the outer intervals are dilated [6, 42]; or when the coupling with successive local states of a force field in some closed volume (say, the $\sim 750 \text{ cm}^3$ of brain grain of human observers) determines variations in the speed of another field's force carriers volumetrically interspersed with the force carriers of the former field: say, outer relativistic particles traversing, neutrino-like, all the way through the volume [3]. Inasmuch as dynamics makes a special subset of kinematics, these general relativity, energy-injection cases (*i.e.*, microphysical circular trajectories, and coupling of a force field's action carriers with another force field's intensities across which the former traverse) just involve special cases of the Lorentz-Fitzgerald effects, expressed by the Valatin-Bogoljubov transforms. They demonstrate that no matter the magnitude of the involved distance, this concept, *distant present events*, is still used in special relativity when the *existence* of the physical objects involved in this relativistic effect is described in three-dimensional language.

When A and B meet at M what everyone of them measures is what *exists* for (*pròs*) him – as Petkov also says [1, p. 11], 'his' *present* rod or segment of A's travel path, that is, all parts of the spatially extended three-dimensional rod or travel-path's segment which exist simultaneously at the instant 'now' of the observer. The travel segment or three-dimensional rod constitutes a set of *distant present events* and both observers must use its non-relativistic definition in order to talk about a three-dimensionally definable travel segment or 'rod' operationally locatable in an overlap of their semiotic referrals. A like situation occurs in the time dilation effect [35, chapter 5]. Yet in order to show that observers need not agree on which events are simultaneous those observers need to stand in relative motion, a translationality that precludes to occupy a single spacetime point, bringing in a

concept of 'distant present eventuation' that in special relativity cannot achieve meaning. Thereby *kinematics demands dynamics*: taken together with the fact that physical signals take time to enable semiosis, the very relativistic meaningless of distant present eventuation implies that according to sheerly kinematic special relativity nothing in nature escapes efficient causation; as Petkov observes, implies that *according to special relativity nothing sheerly three-dimensional stands in the objective subuniverse*.

In the case of length contraction each of the observers A and B in Fig. 3 measures a three-dimensionally definable travel segment or "rod", the respective denotatum, which is neither a purely subjective construct nor an extramental objective "thing in itself". What this description depicts is the travel segment's or rod's worldtube. Its semiotic or referential existence is deduced from the existence of length contraction – if the worldtube did not be referred to no length contraction would be possible to ascertain.

5.6. The physical status of semiotic objects. A's and B's rods or segments of A's travel path – 'for' existences, denotata, *tá pròs ti* – are not extramental because the rod's or travel-path segment's worldtube is an indivisible four-dimensional entity. Despite its being referentially segmented (as distinguished from other segments of the travel path), it cannot be sliced into sheerly three-dimensional cross-sections. This occurs because Minkowski spacetime is not objectively dividable likewise. Thus the absolute, extramental rod or segment of A's travel path efficient to cause absolute (non-frame dependent) active or passive effects independently of its being observed is of course not the same as, or reductable to, its 'for'-existences in observers.

These 'for'-existences are always molar or undecomposable below a certain macroscopic scale [6]; if sensed (rather than abstractly minded of) are always molarly intonated with sensations of the observer, semiotically referred to them; these 'for'-existences consist of or are constituted as parts of the observer ('mental contents'), defined in the general terms of the operations available in the observer's developmentally evolved system of operations [7, 33, 43, 44] and can feature only a predicative combination (concept) that leaves outside any idiosyncratic differences (and so, in case that an existentiality came to inhabit the rod or segment of travel path, cannot pinpoint his or her cadacualtez [2, 6]). Therefore the three-dimensional rod every observer measures according to special relativity is just a *description* of the rod's or travel-path segment's worldtube in terms of the ordinary three-dimensional language.

Setting it up semiotically, or enacting its semiotic existence, is a condition of possibility for relativity, inasmuch as relativity is an interconversion descriptive tool for finite, located or circumstanced observers to reciprocally ascertain their respective perspectives.

This situation, Petkov states [1, p. 12], "is analogous to the one that arises when the $x - y$ planes of different coordinate systems 'cut' different two-dimensional cross-sections of a cylinder – those sections are not real two-dimensional objects since the cylinder itself is not objectively divided into different two-dimensional cross-sections." It does no matter that, as professor Mondolfo used to stress in private talks [Prof. Crocco, pers. comm.], Apolodorus probably

made some cones in remarkably thin gold sheets in order to gain precision for his studies on conic sections.

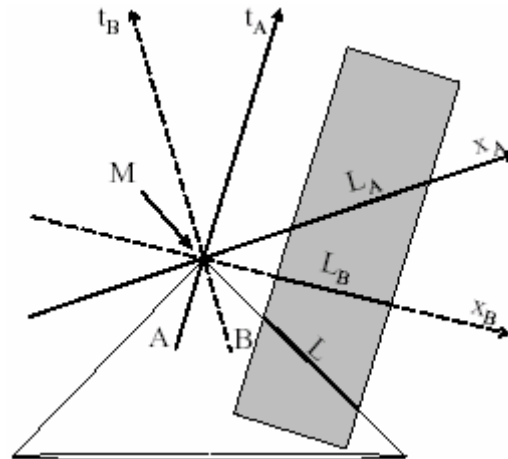


Figure 4: Petkov [1, p. 12] refers to the figure above, on which the following should be noted.

What observers A and B see each in his or her buildup is semiotically referred to the *same* cross-section L of the distant rod's worldtube. For distant elements, "same" means that, among the operatively ascertainable coincidences of the subuniverse descriptions by several observers, the referred-to object can be operatively identified as keeping the same relationships with the remaining coincident objects of their mental worlds, the adequacy of which worlds has developmentally been attained by means of independent spontaneous probings [43, 44]. In general, when two observers A and B in relative motion meet at event M they see the past light cone – whose solid angle is constant because of the 'equivalence principle'. Note that the semiotically referred-to objects L_A and L_B are in the present, which of course rigorously (but exaggeratedly in the figure) stands outside of every circumstanced observer's lightcone.

5.7. Inescapable retardation of embodied observers. Rigorously, it is not the case that we watch three-dimensional things and a three-dimensional subuniverse. It is seen in Fig. 4. Leaving aside neurobiological time-resolution constraints that impose present moments far larger than physical instants [6]; and leaving aside, too, the apprehension advance amount \dot{A} [3, § 1.3.13: "The apprehension advance amount, \dot{A} ", pp. 343-352] that the high-level, non-relativistic 'batch' neuroprocessing imposes on sensory data¹⁵, observers A and B, who are in relative motion, have different sets of simultaneous events and therefore different three-dimensional subuniverses, but at event M they both see quite precisely the *same* thing – the past light cone. In the caption to Fig. 4 it is explained what 'same' does mean for an outer reality being semiotically referred to *by more than one observer* which developmentally attained a certain epistemological adequacy. However,

¹⁵ Reptiles (one may think of a bird; birds are archosaurian reptiles) in order to see perform sudden jerkings to the front with the whole head. Their brain and brainstem collate the initial and final 'instantaneous' eye images of every jump, so as to form the three-dimensional scene. Yet those initial and final neurobiologically 'instantaneous' retinal images are in no way physically instantaneous. Each of them is a sensory batch formed along a physically sizeable interval, maybe over 10^{41} Planck instants long. Humans, which are synapsids and not reptiles, do nevertheless the same, but rather than whole-head joltings we perform the jerks with the eyeballs' positions in their sockets. We are blind during the eyeballs' jumping motions (called physiological nystagmus) that together add to about a half of our awake life. Similar sample integration processes are found in other senses.

because of light speed, this past is just quite recent. It in fact stays within the apprehension advance amount Δ :

"That is, one is always ahead of the times represented by one's brain. This outdistancing is important to bear in mind. One's advancement is a fairly appreciable fraction of a second, the said apprehension advance amount Δ . It is the time taken by dissimilative neurodynamics to compose the brain state to which the circumstanced mind instantaneously reacts ... differentiating the sensory experience of the 'current' moment. In other words, the apprehension advance amount Δ is the time that the brain organ takes (through a complex articulation of microphysical causality) to dissimilate the latest ostensible (or manifest) physical contents which the therein-circumstanced person is to (molarly) differentiate as diverse sensorperceptual mental contents at every moment." [3, p. 344]

5.8 The overthrow of simultaneity. Paying due heed to these circumstances, we can start to explicitly address the question of existence and dimensionality of the objects ('fundamental particles', not-so-fundamental mesons, rulers, clocks, leave-taking twin organisms, etc.) and of the subjects (circumstanced observers) involved in the relativistic effects. Because of neurobiology, one *would not say that our brains integrate the times of many instants to create an observed moment, but that brains dilate the time of an instant to create the observer's temporal modulus that we call moment* – and, by regionally varying the dilation, put the sensory products into the attentional focus or, either, in disattention [6, 10]. Here it matters to remark that, also because of it, we know that efficient causation can be exerted across relativistic frames, as observer-brain interactions show.

Efficient causation apt to be conveyed from one relativistic reference frame to another, across macroscopic ranges, is instanced of course by the nomic action of physical fields of force – segregated as modalities for interaction in our available range of energies – whose action carriers are not stopped by special circumstances such as acquiring inertial mass, as it rather is the case of gluons, and so have outer reference-frame time (locally do not enjoy time) to travel long distances before winking out of existence. Light is the most familiar of these massless carriers of the efficient causation whereby photons may signal their own emission event across relativistic frames. This physical aptitude makes semiosis 'transframable', *i.e.* amenable to relativistic transframing.

Because of the observer's time acuity (which for sight encompasses several thousand kilometers at relativistic speeds, while in more astronomical situations the signals' delay of course exceeds our indefinable, sizable apprehension advance amount Δ), the points of the past light cones at M do not correspond to the *same* instant of the time of each of the observers. In particular, A and B have different three-dimensional rods or segments of A's travel path. But at every physical instant they could only properly denote the *same* three-dimensional cross-section L which, however, cannot be regarded as a sheerly three-dimensional travel-path segment or rod – since all parts of a three-dimensional object exist *simultaneously* at one instant (the instant 'now').

The fulcrum of the whole analysis is that, by contrast, the parts of the three-dimensional cross-section L correspond to different instants of the time of each

observer¹⁶. This is very important but also very well known, so that it often is simply skipped over.

Yet it makes a condition of possibility in special relativity. Namely, figuring this situation in special relativity inescapably *requires* to figure that the parts of the three-dimensional cross-section *L* correspond to different instants of the time of each observer. It follows from here that it is not possible to interpret the length contraction in a sense that it is the *same* three-dimensional segment of A's travel path or 'rod' that 'exists for' A and B, but they could only see it differently. A's and B's semioses generate different denotata.

The observers cannot measure the length of their respective A-travel-path segments or 'rods' at M. This is so since measurements take some time and as discussed each of the observers receives the signals and *a fortiori* perceives his A-travel-path segment or 'rod' a little later, not at the instant when light signals left simultaneously the slightly different but always distant end points of the A-travel-path's segment. But if the observers take into account these delays, they arrive at the conclusion that at the event M they *had* sensory reference to different sets of simultaneous events and therefore *different* three-dimensional A-travel-path's segments or 'rods'.

So, the fact that body and often parts of the surroundings interpose in such a way that observers' experience are not usually in an immediate causal interaction with what they measure does not affect the conclusion that A and B have different three-dimensional A-travel-path's segments or 'rods'. Whence on a purely three-dimensional presentist view and on the other hand neglecting that observers perdure outside of time courses, the length contraction effect is impossible. On a purely presentist view scenifying a subuniverse of null time-like thickness, *i.e.* lacking any intervalic extension of actuality whatsoever, no observer exists for – or could undergo – these semiosis-dependent effects.

This properly shows how the peculiar dependence of relativistic descriptions, on the possibility of assuming a space-akin, navigable time-dimension, does its job. Although the fact that A's and B's semioses must of need refer to different three-dimensional rods – whereas the referred-to rod stays locally invariant so as to efficiently cause invariant effects – is a direct consequence of relativity of simultaneity, it is worth to consider a thought experiment in which the measurement of the rod's length is *instantaneous* in A's and B's reference frames. By its assumed being instantaneous, such a measurement escapes light cone and this is where the *Gedankenexperiment's* importance lies.

5.9. Proof two: simultaneous presence of converging outcomes from distant sequential events. This thought experiment, presented in comparable forms by Steven Hales and Timothy Johnson [45] as well as by Petkov [1, 35], will also

¹⁶ The fact that the subjective-time's graining (divided in moments, not in instants) is too much coarse for detecting any relativistic effect while scanning the surrounding, ordinarily-perceivable events, and that what we thus see are images which cannot be directly interpreted to represent three-dimensional objects (for which they require apperception), is itself another indication bolstering the PPPPPP injunction that our senses cannot be fully trusted especially when it comes to such fundamental questions as the dimensionality of our subuniverse. In the contemporary research of observer-brain relationships (summarized, *e.g.*, in [3]), however, the hackneyed contrast of sense and intellection has become greatly undermined.

provide additional arguments supporting the claim that the three-dimensionalist view contradicts the experiments which confirmed the kinematic relativistic effects – which effects, as a matter of fact, do occur in a nature with observers who by means of efficient interactivity develop mental worlds apt to contrast being and possibilities.

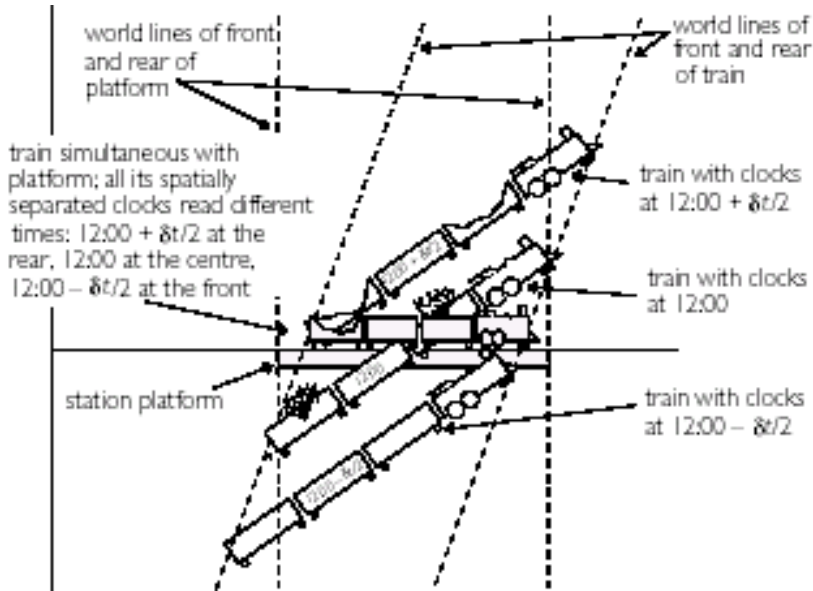


Figure 5 a: Simultaneizing outcomes from distant sequences. Hales and Johnson's schema in "Endurantism, perdurantism and special relativity" [Ref. 45, p. 536], reproduced with permission from *The Philosophical Quarterly*. Hales and Johnson comment: "This seems to drive a stake through the heart of presentism: if t_1 is now, and t_2 is not now, that things at 'not now' can co-exist with things at 'now' seems to indicate that things at other times are certainly real. But it poses just as serious a problem for the endurantist. ... The object does not have all of its parts present at one time."

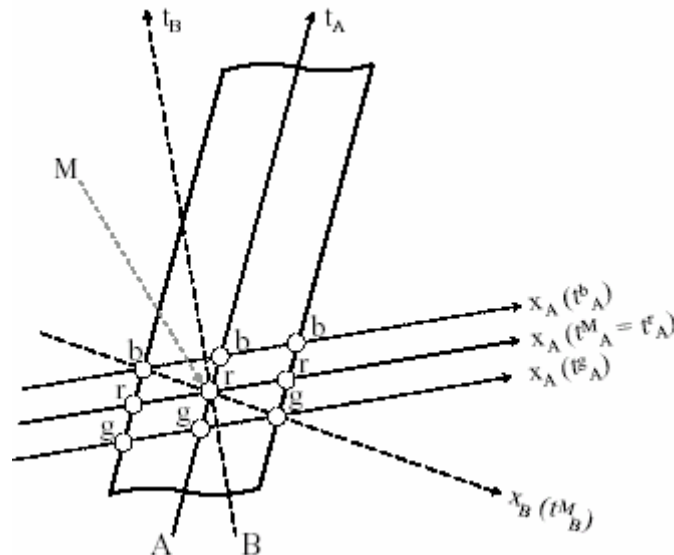


Figure 5 b: simultaneizing outcomes from distant sequences. Petkov's schema as provided in its Internet publication [Ref. 1]. Observers A and B, who are in relative motion, meet at event M. A rod – namely, a small piece of the path – moving on with A and pointing in the direction of motion, *i.e.* at rest in A's reference frame, has lights mounted on its two end points and on its middle point. In A's frame all lights of the rod were simultaneously green an instant before the meeting with B; they are all red at the instant of the meeting, and their color changes simultaneously to blue for A an instant after the meeting. Each of A and B determines the rod's

length *instantaneously* in his frame by taking snapshots of the rod's end and middle points with cameras placed at different points on A's x axis and on B's x axis along which the rod moves. The rod which B measures is present and consists of parts of A's past rod (with the green light), present rod (with the red light), and future rod (with the blue light).

This pretended scenario differs, from the trivial case in which letters posted at diverse date arrive and cause their effects together, in that *the very posting* is sequential for the dispatcher but simultaneous for the receiver. Let the small piece of the path, *i.e.* the rod, again be at rest in A's reference frame (Petkov), analogous to the train's rest frame (Hales and Johnson). I will refer to the rod; while on the train the marking events are detonations, there are lights mounted on the end and middle points of such moving segment of A's travel path or 'rod'. In A's *reference frame* the color of the lights changes simultaneously every instant. As this has no physical meaning, whether in a sheerly three-dimensional subuniverse at all deprived of intervalic thickness or in a block universe whose uncollapsed fourth dimension is physically undemarcable, and as we do ignore which is "the ultimate modulus of [possible] transformational change, namely the minimal interval over which a causal transformation is at all possible or might be marked off by two different instants" [6], I will take it to mean that the color of the flashes changes every Planck instant. (No energy bill for creating such unforetold avalanche of visible-light photons: remember, this is a *Gedankenexperiment*; otherwise each of these physical transitions takes not 'an instant' but more than 10^{19} Planck instants, namely what takes traveling the size of a full hydrogen nucleus at the speed of light, in order to occur, not to mention to be recorded).

Specifically, one instant before the meeting of A and B, for resting or local observer A all three lights on the fixed segment of her travel path or 'rod' flash *green*. To be a bit more precise: while standing apart on some physico-chemical structure of the rod, every one of the three signaling atoms underwent an electronic transition whereby one of its electrons is now emitting a photon carrying physical action to closely enact, through its future absorption, a well-specified distant change, *i.e.* the photon oscillates with a wavelength determined somewhere between, say, 500 and 550 nm. These three green emissions take place at the instant t_{gA} .

Next instant, that is at the very instant of the meeting $t_{MA} = t_{rA}$, for the resting or local observer A the three lights are red (the photon-yielding transitions have been smaller, so every one of the three signaling atoms of the rod emits a photon of greater wavelength, between say 650 and 680 nm) and one instant after the meeting the three lights are blue at t_{bA} (larger electronic transitions caused every signaling atom to emit a photon of shorter wavelength: between, say, 440 and 470 nm).

At each of the three mentioned instants, therefore, the three emitted photons start oscillating ('are created') carrying across space the respective amount of physical action ('energy'), without being able of being observed in travel (observation would absorb or annihilate the action carrier) or of modifying in travel the amount of physical action. First a volley of three green photons left the rod, one instant later a volley of three red photons departed, another instant later a volley of three blue photons did leave. They are assumed (not absorbed, not observed!) by local observer A to carry the mentioned energies, labeled as mentioned: first green, then red, then blue.

Let us introduce B, hastily approaching the meeting zone. At a distance, B moves relativistically; B not either could verify each photon's energy without absorbing (annihilating) it. Only one of the two observers, therefore, either the local or the remote but not both of them, enjoys the possibility of empirically ascertaining how much physical action in on each photon – so as to insert the empirical datum ('color') in his or her semiotic process.

As seen in Fig. 5b, A and B move along their crossing x axes and, being a segment of A's travel path, A's rod is positioned parallel to A's x axis. Both A and B are assumed to use some magic instantaneous detectors, nevertheless called 'cameras', at different points of their x axes. All cameras have clocks which have been synchronized in advance in each frame by using the Einstein's rule assuming that the back (some photons) and forth (other photons, created at best after time-consuming characteristic processes) velocity of light in A's and B's frame is the same. The cameras have been 'synchronized' in such a way that all clocks in each frame show zero for a long time, all along the event of the meeting M – say, for a millionth of a hundredth of a second if the berth of the relativistic-speed meeting is 3 m. This is about 10^{35} Planck instants, *i.e.* $\sim 10^{16}$ times longer than the time needed for interactions of this species to become determined (though their effect, in order to be enacted, would still demand much more time than that, depending on the absorbing system). But as mentioned, observers are not pointlike, and for a *Gedankenexperiment* it is needlessly cumbersome to assume that certain occurrences are unrealistically nontemporal or instantaneous and *also* the meeting space is unrealistically inespacial. Hales and Johnson introduce a railway station, yet the encounter's scale is not set up by its platform's length but by the meeting berth allowed by the setting's time resolution. Though Petkov does not consider it, let it thus take place on a scale of some 3 m

This of course leaves speed indeterminate, but the inertial mass, of the physical system circumstancing the observers to interact, legitimates one for assuming the speed's magnitude continuous with its values at the previous and ensuing states.¹⁷ When A and B meet at M-zone during the interval of $\sim 10^{35}$ Planck instants along which the clocks show $t_{MA} = 0$ of A's time and at $t_{MB} = 0$ of B's time, A and B determine the length of the small segment of A's travel path or 'rod' *instantaneously* in their reference frames by taking camera snapshots of its distant end and middle points. Each snapshot captures the three photons, recording their effects; A's camera is hanging elevated so it captures the rod's three lights from the same distance that passerby B does at the latter closest approach, from a slightly different angle. Some time after the meeting A and B respectively collect the single middle picture from each of their three sets of snapshots to see the results of their experiments – and assume that both quasi-local observations (the middle picture in the two sets, A's and B's) date from almost the same, almost locally-shared instant.

They know that it could not be the same instant. Namely, the two observers cannot have detected the same photons, *i.e.* the trio emitted by the 'rod' at some given instant, because every photon can only be detected once – turning whatever extramental causal deed unobservable, as Crocco showed. Not either could they have achieved the purpose by entangling some subsets of the photons' set, whether along the 'rod' or across the observers, because entangled observables

¹⁷ This may certainly be controverted at the Planck scale.

vanish when the correlate does its causal work. They then try to introduce probabilities in special relativity but find that the probability that B identifies which was the recorded instant of A requires unmanageable combinatorics of a far greater number of colors. Nevertheless, for A the three colors were simultaneously the *same*. Would the colors *differ* on the B's set middle picture?

Observer A sees that the three dots of light (each showing the middle and the two end points of the rod) of the sequence's middle picture, timed $t_{MA} = \sim 0$, display the same color: red, red, and red. The immediately previous and ensuing pictures are also timed $t_{MA} = \sim 0$ but show green, green and green; blue, blue, blue: always the same colors. Light signals did carry the physical action which was furnished by their origination in an electronic transition of those precise magnitudes. Observer B also sees that the three pictures show the same uncertain time $t_{MB} = \sim 0$, but *because figuring this situation inescapably requires to figure that the parts of the three-dimensional cross-section L correspond to different instants of the time of each observer*, we must figure that the colors in B's three pictures are green, red, and blue.

We? Yes indeed; *Gedankenexperimenten* say also something about *the subject*: the three colors is what *we* should figure that B observes. Wavelengths of the photons emitted at the rod's ends may have shifted, or not; *we* must figure that they did. *We* cannot dodge it. It is condition of possibility for *us* to make relativistic portrayals. Hales and Johnson cannot elude supposing that their station onlooker observes the simultaneous state of the passenger in the train at once with his past at the front and and future at the rear of the speedy train, so that they exclaim, "*Clearly the train does not exist 'all at one time'*". Is this a simultaneizing of past, present, and future perduring realities, or either a Doppler effect in efficient causation-acknowledging, collapsed fourth-dimension subuniverse?

5.10. *Discussion of Proof two (Gedankenexperiment)*. Condition of possibility for having relativistic descriptions is that the later account becomes presented as the former. But let us consider this conflation in some detail. Let me add the unsustainable supposition that also M takes no more than a single instant (in this case observers should be some 10^{35} times faster than light and it would hugely *diminish* [2] dilations and contractions, but the question still makes sense) and now ask what exists for A and B at M. As at the instant of the meeting all three red lights of the moving segment of A's travel path or 'rod' are simultaneous for A at his present instant $t_{MA} = t_{rA}$, what exists for him at M is the all-red segment which lies in A's present. The green segment existed for A one instant before the meeting and is in his past while the blue segment will exist one instant after the meeting and is in his future. According to the presentist views the green and blue rods do not exist for A at $t_{MA} = t_{rA}$ since they belong to A's past and future, respectively.

The fact that at M in B's present lies a three-dimensional moving segment of A's travel path whose front end point, middle point, and rear end point are green, red, and blue, respectively (B is moving to the left in Fig. 5) means that in relativistic descriptions the green-red-blue A's travel-path's segment, which is present for B, consists of part of A's past travel-path's segment (the front end point with green light), part of A's present travel-path's segment (the middle part of the rod, which is also present and therefore exists for A at the instant of the meeting), and part of A's future travel-path's segment (the rear end point with blue light). As all parts of an spatially extended, three-dimensional referred-to travel-path's

segment exist *simultaneously* at the present instant of an observer, the three-dimensional rod that exists for B at his present instant t_{MB} is *different* from the three-dimensional rod of A existing at his present instant $t_{MA} = t_{rA}$. (The interval or, in the last scenario, event of the meeting M in Fig. 5 is the only common present event for both observers.) The same thing is *not* present for both observers.

The rod – small piece of A's path – referred to by each observer is composed of a mixture of parts of the past, present, and future rods of the other observer and in relativistic descriptions, to repeat Hales' and Johnson's words, "every object has proper parts at different times," "hence no object wholly exists at each moment of its existence". Why does this occur?

Relativity is an interconversion procedure aimed to ascertain what the perspectives can refer to; not what exists outside of perspectiveness. This is why relativity cannot do justice to non-perspectival absoluteness, except precisely in what such absoluteness imposes without admitting mimesis or anamorphosis [3]: *i.e.*, the cancellation of non-being and causal determination of every event as unmodifiably being earlier than some and later than some of the other events.

Therefore, if any doubt subsisted, the conclusion that in relativistic descriptions each of the observers A and B measures a different three-dimensional rod is indeed inevitable and comes from the different simultaneizing with which each perspective offer its object. Petkov says that the eventual performance of anything resembling this specific experiment would allow A and B to arrive at the idea of the rod's worldtube even if they never heard of Minkowski. He points out that

"the observers A and B might fairly judge that the only way to explain their pictures is to assume that the rod they measured exists equally (at once) at all instants of its history in time. Their reason is that the experiment directly confirmed this conclusion: parts of the rod's past, present, and future (which are also A's past, present, and future since the rod is at rest in A's frame) exist *simultaneously* as B's present rod. A's present rod also contains parts of B's past, present, and future rod. This would not be possible if the rod did not exist equally in its past, present, and future.¹⁸ Therefore A and B might conclude that their experiment has a profound physical meaning."

Indeed, things are so. It proves that relativistic descriptions demand to consider that all physical objects are extended in time, which means that in relativistic descriptions they are uncollapsedly¹⁹ four-dimensional.

¹⁸ Petkov observes that the experiment depicted in Fig. 5 deals only with the immediate past and future of the rod, but [at least before one really calculates the Doppler effects on the signals for every segment of their travel and the spatial extension ('size') of the meeting event and where their limits fall (*i.e.*, where their light cones cease to overlap) M.S.], one can add other observers that also meet A at M but their velocities relative to A are greater than B's velocity. The present rods of these observers will contain what relativistically must be described as parts of more distant past and future of A's rod.

¹⁹ Special relativity lacks means to set limits to the fourth dimension's magnitude.

One might note that this condition of possibility differs from the need of considering realistic, not pointlike observers, meeting, railways and flashes. The latter need imposes itself in order to obtain a realistic physical scenario so as to ponder on in philosophy of science, but definitely most practical applications of special relativity will continue paying no attention to it, like in general relativity many calculations directly apply the forces on the bodies' center. But the former differs, as it is a condition of possibility, not a condition of accuracy: one could not neglect such a condition of possibility because it is necessary in order to define the considered scenario as relativistic.

It is not the first occasion in physics that a defining condition, or directly a definition, is utilized to furnish a hypothesis (the uncollapsed fourth dimension, in this case) which is necessary to create the scenario where calculations may advance. Boltzmann, *e.g.*, introduced molecular disorder as the condition that molecules must satisfy in order to make feasible one of the steps in his derivation of the collision rate among gas molecules; Planck likewise defined natural radiation by means of a mathematical condition that the field's Fourier components must satisfy in order to allow the derivation of his theorem of H ; Minkowski four-dimensionality with uncollapsed fourth-dimension, likewise, works as a condition allowing to build relativistic scenarios.

Validity of special relativity can be thus considered a definition of the statement "events occur in uncollapsed, navigable dimensions". Or, to say the same more historicistically: in order to refrain from introducing efficient causation in describing transformative sequences, time is to be presented as a navigable dimension.

A and B might further believe they can claim that a single experiment, which allowed a single interpretation, proved the uncollapsed four-dimensionality of the subuniverse, entailing that things indeed are as PPPPPP's needs. Yet not everything seems entirely plain. Erstwhile this further belief might have been contested from the very PPPPPP's side: a philosopher of science rigorously adhering to subjectivisms or phenomenisms would have immediately disagreed. He would have pointed out that the claim is based on an implicit ontological assumption – that the existence of the physical objects is *absolute*, *i.e.* observer or frame-independent inasmuch as resulting from transformations enacted by frame-invariant efficient causation. Nowadays, as the reality of the latter is now recognized (§ 1.5) from the empirically ascertained need of sequential interactivity – wherein the mind-originated probings enact absolute motion – to acquire befitting knowledge of extramental occurrences, denying the absolute existence of products of such absolute causation is no longer tenable. Since this claim is deduced from experiments no other ontological assumptions seem to be needed.²⁰⁴⁶ Still an

²⁰ Xenochronic observers peep into time courses through different spatial volumes, *i.e.* parcels of nature of different extension. While the gray tissue in the brain of adult snake *Leptotyphlops emini* is less than two cubic millimeters, adult mice brain gray is less than one cubic centimeter, adult human's some 700 cm³ and adult sperm-whale's reach around 4000 cm³ [45]. Imagine that two inertial observers A and B and an accelerated observer C peep into time courses through physiological arrangements that may be accommodated within the meeting volume and meet at M (but A's frame is not C's comoving inertial reference frame at M). C's present rod will again be relativistically presented as a mixture of A's past, present, and future rod and the conclusion that the rod's worldtube must exist as something *pròs ti* follows. B and C will have the same contracted rod that consists of parts of A's past, present, and future rod.

inauspicious ambiguity, if in the loom, may however cast its dimness on the further belief, as the speed that any observed clock appears to run depends on whether it is traveling away from or toward the observer. Why? Even before performing the conscientious Doppler analysis of the experiment's signals commented in what follows, a philosopher of science will pinpoint two putative interpretations:

(i) if extramental existence is absolute, the simultaneous existence of parts of A's past, present, and future rod as B's present rod (and vice versa) does lead to the conclusion that either the light signals' redshifting and blueshifting accounts for the result or the rod must exist equally at all instants of its history;

(ii) if existence is relative (observer- or frame-dependent), each observer will claim that it is only his three-dimensional referred-to rod that exists – an option to be discarded on the reasons indicated in §§ 1.5 and 2.4, as well as the just mentioned fact that relativity is a tool to interconvert perspectives, lacking means to probe what exists outside of perspectiveness.

At the articulation in which Kant, after his transcendental deduction of the categories, refrained from affirming that he was portraying the 'noumenon', A and B are convinced that it is only the experiment that decides whether the subuniverse is three- or four-dimensional. Of course, facing the effective results of the experiment, they agree that, formally, 'existence' in special relativity can be regarded as relativized (namely, posited as relative to some reference frame, coordinate system or observer, and so made relativistically meaningful) by the simple recourse of referring relativistic descriptions to denotata. But can their further belief agree to viewing 'to be' as 'to be denoted'? A and B realize that such an assumption preserves the three-dimensionality of the special relativity's description of the subuniverse, but it is an alternative option to the conclusion of a four-dimensional subuniverse only in the case of the *reciprocal* length contraction and time dilation which are based on relativity of simultaneity. That is why A and B, like Petkov and us now, concentrate their attention on the twin paradox. Petkov [1, p. 17] explains: "As it is an absolute, not a reciprocal effect, no relativity of simultaneity is involved in its explanation and therefore the relativization of existence should not be an alternative explanation. ... the derivation and the explanation of the twin 'paradox' (Fig. 6) are based on the triangle inequality in the pseudo-Euclidean geometry of spacetime which *presupposes the existence of the twins's world-lines* (in order to be able to talk about a *triangle in spacetime*)."

5.11. Proof three: the twin paradox. Careful ascertaining of how long it takes light to travel in-between explains the supposed paradox, its directional constraint, and even alterations in the signals' power to cause effects (redshifting) as they approach lightcones [47]. Petkov observes that the relativistic explanation of the twin paradox is in the framework of the four-dimensionalist view, and summarizes a long literature by pointing out that "the length of twin B's worldline between the event of the departure D and the event of the meeting M is shorter than the length of twin A's worldline between the same events (in Fig. 6 twin B's worldline is longer but this is caused by the representation of a pseudo-Euclidean relation on the Euclidean surface of the page). This means that B measures less time between D and M than his brother."

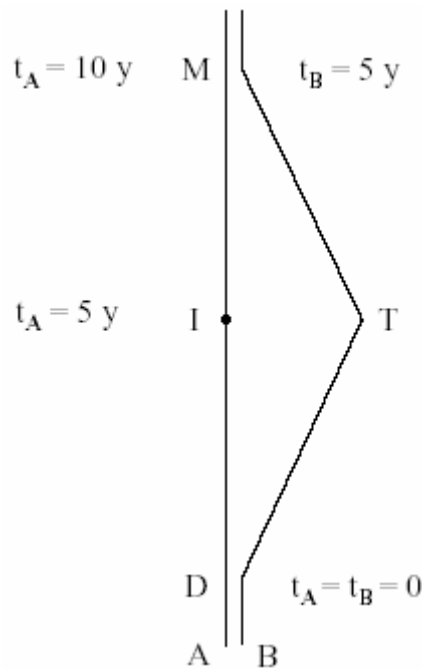


Figure 6, from [1], p. 17. Twins A and B are represented by their worldlines. At the event of departure D twin B starts a journey at a speed that is close to the speed of light. At event T he turns back and meets his brother at event M. As it now is fairly divulged [48, 49, 50, 51], with careful use of the time it takes light to travel between the two the pseudo-paradox gets elucidated.

In view of that, Petkov says, "the only way for the twins to explain the five-year difference of their clocks' readings at M is to assume that twin B's time has slowed down. But this is precisely the problem for the three-dimensionalists – the rate of the proper time does not change according to special relativity (proper time is an invariant) which means that when A and B meet at M their clocks should show the same time." Yet special relativity is valid only in a four-dimensional subuniverse represented by Minkowski spacetime and meticulous relativistic descriptions [47, 48, 49, 50, 51] clearly demonstrate why twins differ.

5.12. *Proof three: discussing the twin 'paradox'.* In contrast, the sheerly three-dimensional view of relativized existence by its need of untenably resorting to acceleration contradicts the now plain experiments that confirm the twin paradox. (Petkov develops the point in [35, Chap. 5].) But the acceleration to which B is subjected has been ruled out as cause [52, 53, 54, 55, 56]. Hence the three-dimensionalist view resorting to acceleration cannot explain why twin B is younger which means that this view cannot as well explain the twin 'paradox'²¹.

While no scientific tool is non-theoretical, in the current scientific context that concurrently finds the transframing of efficient causation and causal initiatives as requisite for epistemological accuracy, the interpretation of the experiments

²¹ Petkov wrote, "It may appear inviting to "explain" the different readings of the twins' clocks by saying that time is frame-dependent in relativity. However, this is not an explanation at all since the very question is: Why, [if causation is frame-invariant and its absolute products are given just once at a time, yet] is time frame-dependent in relativity?" (Square brackets mine). As at this point it should be surfacing, answer is: because relativistic calculations ought to spatialize time, or, four-dimensionality is a condition of possibility for relativistic descriptions – legitimately applicable to phenomena, but whose use for noumena is incorrect, to put it in Kant's expressions.

which confirm this theoretical result has a say regarding the aptitude of the relativity's conditions of possibility to *also* detect the dimensionality of the subuniverse. *We only know that this procedure for interconverting the perspectives of localized observers, namely relativity, must inescapably assert that we live in a four-dimensional block universe in which the whole histories of all objects are realized in their worldtubes.* Even when quantum theorists such as Myrvold seek a "collapse theory that is genuinely, metaphysically compatible with special relativity" [57] understand it "in the sense of depicting the world as 'unfolding within a four-dimensional Minkowski space-time', to use Albert's [58: Myrvold's note] picturesque phrase." Special relativity depends on a condition of possibility that *a priori* decides the issue of the dimensionality of *its descriptions* of the subuniverse at the macroscopic level. Could this situation be used to learn anything about any other reality besides the relativistic calculations themselves?

6 Different Descriptions Versus Different Ontologies

Harrington recently [59] wrote: "Gödel argued that absence of global time in relativistic space-time is sufficient to disprove the existence of time itself. Gödel thus became the first, as far as I am aware, but not the last thinker to claim that relativity theory solves all philosophical problems about time by dissolving them." Without going so much far, the depicted situation may indeed help to rule out three-dimensionality. As Petkov says, not only would the kinematic relativistic effects be impossible if the subuniverse were three-dimensional, but the experimental evidence which confirms them would not be possible either. This seems serious. Without relativity of simultaneity there could not be equivalence of mass and energy, thus there would be no limit under which their conservation has a break, thus action quanta could not set correlated limits for their determination, thus there would be no virtual particles, thus no physical forces, thus no particles could be held together, chemistry would not exist, without chemistry there would be no biology, and without biology there would be no way for action-initiating minds to interactively attain intellectual development [10] – so without relativity of simultaneity any present reader should be able to verify that he or she is an angel with infused knowledge.

One should consequently conclude that any effort and money spent in one's education was a miserable failure (authors might also use the *Acknowledgements* section to deprecate their teachers) or recognize that deeming actuality sheerly three-dimensional challenges genetic epistemology, defying our shared developmental experience. Nevertheless, were relativistic calculations performed on three-dimensional assumptions, "any experiments designed to test the three relativistic effects we discussed – relativity of simultaneity, length contraction, and the twin [pseudo-]paradox – would detect absolute simultaneity, no length contraction, and no time difference in the twins' clocks' readings", so that the present cannot be of null time-like thickness or interval-like infinitesimal. One thus may find oneself legitimated for rejecting the three-dimensional ontology; yet, not because relativity alone says it, or because the three-dimensional ontology differs from the ontological assumptions which are to be posed in order to make relativity operational; but, rather, because relativity can be integrated with other contemporary insights from diverse fields, some of which such as neurobiology, genetic epistemology, and history of ideas I commented above. In such a company,

relativistic calculations work fine for interconverting perspectives. Can we go beyond it? Petkov explores if it is true "that relativistic mechanics does not carry a particular ontological interpretation upon its sleeve", as Balashov says [60], finding that relativity can operate on a *sine qua non* condition which does contain just one ontology – the uncollapsed four-dimensional ontology – which is deducible from those effects. Kant rather warns us that conditions of possibility do not yield any accurate knowledge whatsoever about what stays beyond their molding aptitude. Could we ascertain, upon any insight coming from this situation, if the macroworld's fourth dimension stands uncollapsed or, instead, time dimension collapsed in magnitude so as to match the efficient causation features?

My current answer is negative and negatively grounded. I do not see how to jump, from the legitimate use of an uncollapsed fourth dimension in relativistic calculations aimed to interconvert perspectives, to agreeing or disagreeing with the coherent articulation of seemingly well-validated knowledges from other academic fields providing support to the view that nature is an efficiently transforming reality, in which transformations flow with a pace set by causation's features and changes are irrevocable, things existing only a timelike instant each time, so that, *e.g.*, the present now is the same that any one of Precambrian times transformed. A nature, in sum, in which the rate of time flow or transformations' 'pace' should be ascribed to causation's inner features that are, themselves, tantamount to spreading action on a fourth dimension whose span collapsed into a present-now's timelike "thickness" which precisely allows causation to enact change.

Conclusions

Because what Minkowski came across is a Kantian condition of possibility for relativity, time in relativity is frame-dependent, in its descriptions future is determinate, and relativity harbors no alternative to the block universe view. It implies that special relativity is valid only in a four-dimensional world represented by Minkowski spacetime. Yet no grounds are in view to assume that special relativity *alone* be able to provide a definite proof of the block universe view, save that one has previously refused to recognize reality to efficient causation, both to nomical ("nature's") causation and personal ("conation" or "will") causation, as well as to any residual, time-like thickness of reality that could match the action requirements of such efficient causation enabling it to set real transformative courses. This Platonist view is found associated with an anthropology serving certain interests (presenting people as robots) which, by their being ideological⁶¹, fall outside of the scope of the present article.

Acknowledgements

The author got indebted to Lee Seldon for a clever formulation used in § 5.8 (*italics*); she is also grateful for a special waiving of her other responsibilities in the Neurobiology Research Center granted from the 1st to the 25th of July, 29th and 30th of August 2005 in order to work on the present essay. Vesselin Petkov started it by friendly sharing his paper in June with the words, "I hope you will address the arguments there"; author is very grateful for the occasion and, even differing about relativity's aptitudes as ontological tool, much wishes to have met his expectations.

Appendix

Excerpta (taken with permission) from [2] § 1.3.24, pp. 388-392, "*Intertwining agencies*":

"Willful remembering, moving limbs, or imagining a red tree are semovient acts of esemplastic attention. Is it possible to *allow subjective terms* into supraquantum physics, *permitting it to make predictions about subjectivity*? In these circumstances, the event of experience that terminates every chain of physical measurement cannot be artificially sundered from the plurality of *other* contents in the *same* experiencing mind. Which include, besides the measurement done in each case, also the findings of her own semovient action of attentional reclusterings resisting itself (= cogito); finitude; circumstances; and availabilities. The latter may certainly include scientific notices, of the style of the ones in the preceding pages...

Therefore, the experiencing that terminates every chain of physical measurement cannot doubt that, within the specified stipulations of its object-system's macroscopic depiction of extramentalities and constitution of intramentalities, the notices she grasps about the extramental subuniverse—including foreign *subjective terms*—do resolve *true* facticities. By way of illustration:

- that in every voluntary action, the incumbent finite psycheé experiences her own causative agency in the knitting of some *extramental* facts under her genuine control;
- that the causal-linked relevancies eventuate and transfigure apart from their empirical reflections (in whatever number of minds [that might] observ[e] them), and so they constitute a subset of real events under 'physical laws', mutually imposing regularities on empirical findings, in an impositional way analogous to each finite experiencing's own causative agency;
- that microphysics holds reality beyond the [molar] graininess of the fictions useful to represent it;
- that the causal series, begun by other parcels of experiencing finitude, ensue upon their anomic starting, which is extramental with respect to the aforesaid, observing finite psychism;
- that past and future states not exist and are only anisotropically referenceable; and
- that the physical reality comes into being just one instantaneous present situation at a time. ...

[§§] Extramentalities not originate in any 'prejudice of the (external) world': All this furnishes a *pre-ordered* body of gradients and resistances, that the intramental action *needs* to operate and, on its different frustrations, learn adequately about the extramentality in the self-agential terms of what semoviences can do with their experiential encounters. "As the light dove that, in lively fly, feels the resistance of the air and might imagine that its flight would be still easier in empty space."²² This

²² I. Kant, *Kritik der reinen Vernunft, Einleitung* nach Ausg. B, ss. 8-9: "Die leichte Taube, indem sie im freiem Fluge die Luft teilt, deren Widerstand sie fühlt, könnte die Vorstellung fassen, dass es ihr im luftleeren Raum noch viel besser gelingen werde". Kant immediately continues: It was thus that Plato left the world of the senses, as setting too narrow limits to the understanding, and ventured out beyond it on the wings of the ideas, in the empty space of the pure understanding.

'syntax', of this structural operation with mental contents, may be conceived as the building up of a further inner metrics, one added to the physical metrics whereby *bruta animalia operantur ex passione*, the added metrics being *developmentally acquired* by the mental spaces. I. e.: that of the logic-mathematical operations, those feasible and those resilient to conserve the element of interest; or, the operation reversibly positioning an object —say, an object referring to somebody— in a web of status or of kinfolk intimacy — say, as being such and such next-of-kin in some 'lineage': e. g., the nephew of an uncle and viceversa; a web of rules very variable amongst the cultures, for certain. This acquired metrics is *not* the dimensions: physically, mental spaces in no respect are Hilbert-like, that is to say moulded by a 'coordinate system' of all the object-defining features of the mental *contents*, but only by the structureless ones. These set *constitutive* geodesics; the acquired metrics just chisels operations, in a self-referred system of constraints enacted to attain some operatory result ([2] p. 461). Amidst this acquired metrics, *also* sensoperceptual gradients for object positioning eventuate.

The intramental action encounters all those gradients as a finely itemized, but systematic datum. And must account with them and with the discoverable body of those intrinsic stipulations, feasibilities, resiliences and resistances (whose detail and boundary or initial conditions are not to be analyzed now). *Their picture is so consistent with the finite psyche's observations and experiments; and these, in their cruciality, validate that finely detailed picture.*

Whence its description of nature is *hylozoistic*, since such body of stipulations includes the finding of *foreign sources of actions absolutely starting new causal series upon experienced determinations*. And freedom, as causation, cannot be predicatively shammed.

In its contents, detected *in the biospheric evolution*, this hylozoistic spotting of the causal series determined at a *selected subset* of simultaneous historic states —a discretionary selection which lacks the integrality that would made it equivalent to Newtonian instantaneous causality, and evinces the subjective apprehension imperative in the physical fact of selecting a subset of antecedents for the own time-transformation— is the physics counterpart of the *philosophical* detection which our tradition technically labels as 'recognizing the alien cogito'. Both detections (or recognitions) make contemporary definitions of hylozoism.

On such recognition of other experiencing sources of real actions, any difference vanishes between the finite experiencer's *knowledge* descriptive of this physical universe being

(I) that of a screenplay 'movie', not wholly unlike a dream, intramentally projected (even, as a pattern of 'meanings' —assumed inherent or extraintentional— of a nature reduced to language for a discursive cerebral homunculus, bare of non-simulational insight even of its own intonations and causation, to analyze; screens are instruments to predicationally tailor a posited reality whose unique change is alteration and where waitings are sheer hermeneusis);

(II) and being that of true extramentalities. *This allows subjective terms into supraquantum physics, permitting it to make predictions about the subjectivity of finite psychisms.*

The difference so vanishes, because *upon simultaneous duration* such description does drag, across sentience and unmindfulness, the reality previously recognized to

that absolute origin of new causal series weigh as well of compulsion as of randomness.

So, any such 'intramental movie' with all the sensory input and 'interactive' feedbacks (be it delivered by Cartesius' malign genius, by Leibniz' divine (Pseudo-)Creator making the observer's and the observed's waveforms to collapse in line with the Vedantist function of a Universal Mind, or by a computer along wires plugged into the observer's substrate tissue) *ought* to be detailed enough as for every event to be local, and *ought* to be ticked in an operative time so as to really *produce*, from the lilliputian proportions of microphysics on, such outset of really new causal series. And so *undergo* causal transformation (= mutual deposition of the set of physical actions) with one same physical pace under due relativistic transforms, and including, in its interactivity, the intrinsic direction for its integration ('causal arrow').

If a cinematographic or videogame fictioneering, its totalness or literary sufficiency is *thus* anything but enough. It must also be one, which responds with well-nigh-infinitesimal graininess of *productive* detail. *So much detailed*, that its contents do reciprocally chain causally. With the same univocal, productive and efficient causation which the experiencing experiences in operating with its objects or mental contents. A causation operated through said waitings that the released pendules and all other accelerations do comply with; around the impotency to activate neighbours' limbs and intentions; over all feasibilities, resiliences and disabilities for accomplishing movements with the available body and its accouterments, and their respective delays. All these are 'resistances', not posited by the own agency, whereto nonetheless one's feeling-driven behaviour must adjust itself to causally achieve operations onto its objects. In such a wise, that foreign freedoms and possible intentions enter all dynamic planning and handling to exercise one's causation, being intentioned jointly with the own feasible movements and delays of one's body and accouterments. Thus, this sort of imprisoning screenplay 'supernaturally projected into our soul' can no longer pass off the elapsing and the present as artifacts of subjective perspective. It ought *then* to include real novations: *namely, other experiencing sources of real novative actions, finite inceptors.*

This requisite graining fractures the 'gnoseocapsule'. Turning one's attention inward and minding about what is going on in one's own *mens* is *unstable*, and gets ahold of time-arrowed extramentalities. Experience is found to occur at a *plurality* of extramental dates and sites.

So the empsyched reality *self-adaptively knows of itself truthfully, if scantily*, by evolutionarily seeping into object systems some true notices of its events and constitution and even imposing inflections on its available preferences. Truly causating both fictitious and roughly-adequate causal accounts, and actions in extramentality feed-backing on such notices. Psychai have knowledge necessarily through sensible perception. They know immediately parts of the reality, without any mediating representation whatsoever; and those parts are installed and interact with the remaining alterities of nature through a unique, shared causality.

Extramentalities do not originate in any 'prejudice of the (external) world', as Merleau-Ponty academically charged (but mass-culture turns unacademically repetitious), *wishing to dismiss the eclosional finitude of animal psychisms* by way

of what today should be called 'to present every life as a role, played in a full-brain videogame by some transcendental commiscuum'. And, against what Kant charged in *KrV B 303*, ontology, feasible upon the cogito of the own circumstanced finitude, also becomes possible of its embedding extramentality.

Freedom cannot be shammed. Thus, the stipulations of these object systems to assemble fictions representative of extramental happenings (i. e., the fictions' blunt resolution, or incompleteness down even to emblematicity, as that of mere tokens; and absence of causal efficacy in the represented line of processes) cannot be forced into criterion of reality. On this basis, or by that principle, *finite semovient* observers are enabled to *adequately* infer the ontic occurrence of extramental events, from their experiences of those events."

-
- ¹ V. Petkov, "Is There an Alternative to the Block Universe View?", in: D. Dieks and M. Redei (eds.), *The Ontology of Spacetime*. Series on the Philosophy and Foundations of Physics (Elsevier, Amsterdam), forthcoming in Spring 2006. Internet publication available in <http://philsci-archive.pitt.edu/archive/00002408/>
- ² M. Crocco, Struggling against time: The folk precedents of modern science's mathematizing tradition and the differentiation of the Pythagoric-Parmenidean worldview, *Folia Neurobiológica Argentina* VI, 12-76, 1988.
- ³ A. Ávila and M. Crocco, *Sensing: A New Fundamental Action of Nature* (Folia Neurobiológica Argentina, vol. X: Institute for Advanced Study, Buenos Aires 1996).
- ⁴ N. J. Emery and N. S. Clayton, Comparing the complex cognition of birds and primates, Chapter 1 in Lesley J. Rogers and Gisela Kaplan, eds., *Comparative vertebrate cognition* (Kluwer Academic Publishers, 2004).
- ⁵ J. C. Troiano and M. Crocco, eds., *Biomedicina de reptiles* (McGraw-Hill Interamericana, Mexico-Buenos Aires, 2005); cf. Introd. and Chapter 1.
- ⁶ M. Szirko, Effects of relativistic motions in the brain and their physiological relevance. In Helmut Wautischer, ed., *Ontology of Consciousness: Percipient Action* (A Bradford Book: The MIT Press, Cambridge, Mass.), forthcoming in Dec. 2005. Internet publication available in <http://electroneubio.secyt.gov.ar/Index2.htm/>
- ⁷ J. Piaget and cols., *L'Épistémologie du Temps* (Presses Universitaires de France, Paris, 1964).
- ⁸ A. Grünbaum, Can an infinitude of operations be performed in a finite time?, In *Philosophical problems of space and time* (Boston Studies in the Phil. of Science XII, Reidel, Dordrecht-Boston, 1973), p. 633.
- ⁹ J. Barnes, *The Presocratic Philosophers* (Routledge, London, New York, 1982).
- ¹⁰ M. Crocco, A Palindrome: Conscious living creatures as instruments of Nature; Nature as an instrument of conscious living creatures. In Helmut Wautischer,

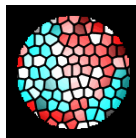
-
- ed., *Ontology of Consciousness: Percipient Action* (A Bradford Book: The MIT Press, Cambridge, Mass.), forthcoming in Dec. 2005.
- ¹¹ Aristotle, *Physics*, Book IV. A translation in: *Great Books of the Western World*, Vol. 7, ed. by M. J. Adler (Encyclopedia Britannica, Chicago 1993), pp. 257–355
 - ¹² Aristotle, *On the Heavens*, Book I. In: *Great Books of the Western World*, Vol. 7, ed. by M. J. Adler (Encyclopedia Britannica, Chicago 1993), pp. 357–405.
 - ¹³ G. Galileo, *Dialogue Concerning the Two Chief World Systems – Ptolemaic and Copernican*, 2nd edn. (University of California Press, Berkeley 1967) pp. 9–10.
 - ¹⁴ A. Augustinus Hipponiensis, *The Confessions*, Book XI. A translation in: *Great Books of the Western World*, Vol. 16, ed. by M.J. Adler (Encyclopedia Britannica, Chicago 1993) pp. 1-159.
 - ¹⁵ R. Dodds, *The Greeks and the Irrational* (University of California Press, Berkeley, 1951).
 - ¹⁶ C. H. Hinton, *What is the Fourth Dimension?* (W. S. Sonnenschein and Co., London 1884).
 - ¹⁷ C. H. Hinton, *Speculations on the Fourth Dimension: Selected Writings* (Dover, New York 1980).
 - ¹⁸ H. Minkowski, Space and Time. In: Lorentz, Hendrik A., Albert Einstein, Hermann Minkowski, and Hermann Weyl, *The Principle of Relativity: A Collection of Original Memoirs on the Special and General Theory of Relativity* (Dover, New York 1952), pp. 75–91.
 - ¹⁹ E. F. Taylor, J. A. Wheeler, *Spacetime Physics: Introduction to Special Relativity*, 2nd edn. (Freeman, New York 1992), p. 18.
 - ²⁰ A. Sommerfeld, Notes on Minkowski's paper "Space and Time". In: [18] p. 92.
 - ²¹ H. Weyl, *Philosophy of Mathematics and Natural Science* (Princeton University Press, Princeton 1949) p. 116.
 - ²² A. Einstein, *Relativity: The Special and General Theory* (Crown Publishers, New York 1961) p. 150.
 - ²³ C. W. Rietdijk, A Rigorous Proof of Determinism Derived from the Special Theory of Relativity, *Philosophy of Science*, 33 (1966) pp. 341– 344.
 - ²⁴ H. Putnam, Time and Physical Geometry, *Journal of Philosophy*, 64, (1967) pp. 240–247.
 - ²⁵ N. Maxwell, Are Probabilism and Special Relativity Incompatible?, *Philosophy of Science* 52, (1985) pp. 23–43.
 - ²⁶ H. Stein, On Einstein-Minkowski Space-time, *Journal of Philosophy*, 65, (1968) pp. 5–23.

-
- ²⁷ H. Stein, On Relativity Theory and the Openness of the Future, *Philosophy of Science*, 58, (1991) pp. 147–167.
- ²⁸ R. Clifton and M. Hogarth, The Definability of Objective Becoming in Minkowski Spacetime, *Synthese*, 103, (1995) pp. 355–387.
- ²⁹ P. Bains, *The Primacy of Relations* (University of Toronto Press), forthcoming in 2006.
- ³⁰ R. Mondolfo, *La comprensión del sujeto humano en la cultura antigua*, chapter IV: "La actividad sintética del sujeto reconocida como condición del conocimiento" (Imán, Buenos Aires, 1955; and EUDEBA, Buenos Aires, 1968).
- ³¹ R. Mondolfo, *L'infinito nel pensiero del Greci* (Le Monnier, Firenze, 1934); *El infinito en el pensamiento de la antigüedad clásica* (Imán, Buenos Aires, 1952).
- ³² M. Crocco, On minds' localization, *Electroneurobiología* 12 (3), pp. 244–257, 2004.
- ³³ J. Piaget and cols., *L'Épistémologie de l'Espace* (Presses Universitaires de France, Paris, 1962).
- ³⁴ R. Weingard, Relativity and the Reality of Past and Future Events, *British Journal for the Philosophy of Science* 23 (1972), pp. 119–121.
- ³⁵ V. Petkov, *Relativity and the Nature of Spacetime* (Springer: Berlin, Heidelberg, New York, 2005).
- ³⁶ V. Petkov, The Flow of Time According to Eleatic Philosophy and the Theory of Relativity. In: *Struktur und Dynamik wissenschaftlicher Theorien*, ed. by C. Toegel (P. Lang, Frankfurt am Main - Bern - New York, 1986) pp. 121–149.
- ³⁷ V. Petkov, Weyl's View on the Objective World. In: *Exact Sciences and Their Philosophical Foundations*, ed. by W. Deppert, K. Huebner, A. Oberschelp, V. Weidemann (P. Lang, Frankfurt am Main - Bern - New York, 1988), pp. 519–524.
- ³⁸ J. S. Bell, How to teach special relativity, In: J. S. Bell, *Speakable and Unsayable in Quantum Mechanics* (Cambridge University Press, Cambridge 1987), pp. 67–80.
- ³⁹ H. R. Brown and O. Pooley, The origin of the spacetime metric: Bell's 'Lorentzian pedagogy' and its significance in general relativity, In: C. Callender and N. Huggett (eds), *Physics Meets Philosophy at the Planck Scale* (Cambridge University Press, Cambridge 2001), pp. 256–272.
- ⁴⁰ B. Rossi and D. B. Hall, Variation of the Rate of Decay of Mesotrons with Momentum, *Physical Review* 59 (1941), pp. 223–228.
- ⁴¹ G. F. R. Ellis and R. M. Williams, *Flat and Curved Space Times* (Oxford University Press, Oxford 1988), p. 104.

-
- ⁴² M. Crocco, United Kingdom Patent 1,582,301 re. Febr. 16, 1976: U.K. Official J. – Patents, Oct. 28, 1980.
- ⁴³ J. Piaget, *Biologie et connaissance: essai sur les relations entre les regulations organiques et les processus cognitifs* (Gallimard, Paris: collection L'avenir de la science, # 42, 1967), cf. specially Chapter I and Chapter IV: 12.
- ⁴⁴ J. Piaget, *Le comportement, moteur de l'évolution* (Gallimard, Paris, 1976: Collection Idées, # 354, 1976).
- ⁴⁵ S. D. Hales and T. A. Johnson, Endurantism, perdurantism and special relativity, *The Philosophical Quarterly* 53 # 213 (Oct. 2003), 524-539. Internet publication available in www.bloomu.edu/departments/philosophy/pages/content/hales/articlepdf/endurantism.pdf
- ⁴⁶ M. Crocco, La cilia de las neuronas centrales, reliquia del tronco común de motilidad y percepción, poster, Escuela Normal de Profesores Nro. 2 Mariano Acosta, Bs. Aires, 1963.
- ⁴⁷ A. P. French, *Special Relativity* (W. W. Norton, New York, 1968). Not all texts explain properly the point: some textbooks that do it are those by R. Resnick and D. Halliday, *Basic Concepts in Relativity* (Macmillan: New York, 1992); David Halliday *et al.*, *The Fundamentals of Physics*, John Wiley & Sons, 1996) and Internet classroom materials such as "Understand the Twin Paradox with High School Algebra" at <http://www.everythingimportant.org/relativity/special.pdf> and "Usenet Physics FAQ: Twin Paradox" at http://www.physics.adelaide.edu.au/~dkoks/Faq/Relativity/SR/TwinParadox/twin_paradox.html
- ⁴⁸ P. Tipler and R. Llewellyn, *Modern Physics* (4th ed.) (W. H. Freeman, 2002).
- ⁴⁹ Michael Weiss, The Twin Paradox, online in http://math.ucr.edu/home/baez/physics/Relativity/SR/TwinParadox/twin_paradox.html
- ⁵⁰ Anonymous, 'Twin paradox' article in Wikipedia, http://en.wikipedia.org/wiki/Twin_paradox
- ⁵¹ P. Davies, How to Build a Time Machine, *Scientific American* September 2002; online in <http://www.sciam.com/article.cfm?articleID=0004226A-F77D-1D4A-90FB809EC5880000> See also Davies' book *About Time* (Touchstone 1995, pp. 59 ff.),
- ⁵² C. W. Misner, K. S. Thorne, J. A. Wheeler, *Gravitation* (Freeman, San Francisco 1973) p. 164.
- ⁵³ R. d'Inverno, *Introducing Einstein's Relativity* (Clarendon Press, Oxford 1992) p. 33
- ⁵⁴ G. L. Naber, *The Geometry of Minkowski Spacetime* (Springer, Berlin, Heidelberg, New York 1992) p. 52.
- ⁵⁵ R. A. Mould, *Basic Relativity* (Springer, Berlin, Heidelberg, New York 1994) p. 83.

- ⁵⁶ P. Kroes, The Clock Paradox, or How to Get Rid of Absolute Time, *Philosophy of Science* 50, (1983) pp. 159–163.
- ⁵⁷ W. C. Myrvold, Relativistic Quantum Becoming, *British Journal for the Philosophy of Science* (2002)
- ⁵⁸ D. Z. Albert, Special Relativity as an Open Question, in H.-P. Breuer and F. Petruccione (eds), *Relativistic Quantum Measurement and Decoherence: Lectures of a workshop, held at the Istituto Italiano per gli Studi Filosofici, Naples, April 9-10, 1999*, (Springer, Berlin, 2000), pp. 1–13. [Myrvold's note]
- ⁵⁹ J. Harrington (2005), Special Relativity and the Future: A Defense of the Point Present. Available at
<http://philsci-archive.pitt.edu/archive/00002139/01/TimeSurvey.pdf>
- ⁶⁰ Y. Balashov, Enduring and Perduring Objects in Minkowski Space-Time, *Philosophical Studies* 99 (2000), pp. 129–166.
- ⁶¹ M. Szirko, L'anthropologie ganglionnaire, un psychovirus démasqué, *Electroneurobiología* 10 (2) (2002), pp. 45-60; available online in
<http://electroneubio.secyt.gov.ar/index2.htm/>

Copyright © August 2005 del autor / by the author. Esta es una investigación de acceso público; su copia exacta y redistribución por cualquier medio están permitidas bajo la condición de conservar esta noticia y la referencia completa a su publicación incluyendo la URL original (ver arriba). / This is an Open Access article: verbatim copying and redistribution of this article are permitted in all media for any purpose, provided this notice is preserved along with the article's full citation and original URL (above).



revista
Electroneurobiología
ISSN: 0328-0446