ZENO'S PARADOXES REVISITED

Anguel S. STEFANOV

ABSTRACT: My aim in this paper is to suggest a new outlook concerning the nature of Zeno's paradoxes. The attention is directed towards the three famous paradoxes known as "Dichotomy," "Achilles and the Tortoise," and "The Arrow." An analysis of the paradigmatic proposals for a solution shows that an adequate solution has not yet been reached. An answer is provided instead to the question "How Zeno's paradoxes emerge in their quality of aporiae?," that is to say in their quality of impasses, of problem situations without an exit, what is the original meaning of the Greek word "aporia." It is my claim that this is the correct rational approach for solving these conceptual puzzles. In other words, I am not proposing formal solutions by criticizing and/or altering their premises assuming the continuous or discrete nature of space *and* time, but I try to draw the philosophical attention to the way we possess the phenomenon of motion as a result of the perception of *space-time* in human experience.

KEYWORDS: Zeno's paradoxes, motion, perception of space-time

1. Introductory Words

Zeno's paradoxes, or aporiae, are permanently attracting the philosophers' interest, resulting in hundreds of research works, as well as of popular essays in textbooks and websites. There is no point to this effect any new effort to be made that repeats and summarizes familiar attitudes to their proposed solutions, if it does not suggest some original outlook connected with these paradoxes.

My aim here is to suggest such an original outlook. It starts with a brief and modest hypothesis about the debated motives for the formulation of the paradoxes. But its essential part is that, after an analysis of the paradigmatic solutions known so far, and of their criticism, *an answer is outlined to the question how Zeno's paradoxes emerge in their quality of aporiae*, that is to say of impasses, of problem situations without an exit, what is the original meaning of the Greek word "aporia." It is my claim that this is the correct rational approach for 'solving' the most popular three conceptual puzzles known as "Dichotomy," "Achilles and the Tortoise," and "The Arrow." In other words, I am not proposing here formal solutions by criticizing and/or altering their premises assuming the continuous or discrete nature of space *and* time, but I try to draw the philosophical attention to the way we possess the phenomenon of motion as a result of the perception of *space-time* in human experience.

2. A Brief Reconstruction of Zeno's Conceptual Motives

There is no unanimous opinion why Zeno formulated his paradoxes of motion. According to the standard and, as it seems, most popular view, he wanted to reject the belief that motion is a genuine process of spatial change through time, since its logical analysis leads to contradictions, and thus he wanted to present the perception of motion as a phenomenal illusion. But not all concerned with Zeno's paradoxes share this standard interpretation.

> Traditionally, most agree that Zeno attempted to build upon Parmenides work. However, some suggest he sought to discredit Parmenides' work; others claim he criticized the traditionally held Greek views on motion; and more recently, interpreters propound that he was combatting Pythagorean thinkers.[1]

There are also authors who contend that Zeno was "a mere ingenious juggler, and his arguments to be one and all sophisms."[2] This lack of agreement comes from the fact that Zeno's writings have not survived, and one has to reconstruct his conceptual motives out of the comments of Aristotle, Simplicius, and Proclus, and by a shortly presented, but important evidence of Plato to be found in the beginning of one of the most philosophically profound dialogues of him, *Parmenides*. Asked by Socrates about the motives of his early writings, Zeno provides the following elucidation of them:

> The truth is, that these writings of mine were meant to protect the arguments of Parmenides against those who make fun of him and seek to show the many ridiculous and contradictory results which they suppose to follow from the affirmation of the one. My answer is addressed to the partisans of the many, whose attack I return with interest by retorting upon them that their hypothesis of the being of many, if carried out, appears to be still more ridiculous than the hypothesis of the being of one. Zeal for my master led me to write the book in the days of my youth, but some one stole the copy; and therefore I had no choice whether it should be published or not; the motive, however, of writing, was not the ambition of an older man, but the pugnacity of a young one.[3]

Being a Parmenides' disciple, Zeno supported with great certainty the main principle of eleatic philosophy, positing that the existing world is one indivisible and unchanging reality, i.e. postulating "the being of one." I am not going to enter any historical and philosophical details here. What is important for my purposes is

---

[1] David Von Valland, "Zeno's Paradoxes, Part I – The Problematic Nature of Infinity and Motion." Article source: http://EzineArticles.com/?expert=David_Von_Walland.

[2] Bertrand Russel, *The Principles of Mathematics* (New York: Norton, 1996), 347. Russel himself does not subscribe to this extreme opinion.

[3] Plato, *Parmenides,* 128c-e.

the fact contained in the just adduced quotation, that opponents of Parmenides ridiculed his attempts at rejecting plurality and the reality of change, if the world were really singular and unchangeable. And the cunning young disciple of Parmenides contrived retaliation as "pugnacious," as hard to be logically surmounted. But why Zeno's paradoxes can be conspicuously taken to attack the reality of motion?

If the real world is one, then no plurality of things has an authentic existence. This implies the idea that motion is illusionary in its phenomenal character. This is so, because motion results in different spatial positions of things within the world, which means different pictures of the world at different moments of time. Different pictures mean many different states of this same world, otherwise taken to be one and unchangeable. Thus the avowal of the reality of motion leads to a clear anti-eleatic view, and so the unreality of motion must be somehow demonstrated. And Zeno produced not one, but several logical arguments demonstrating the contradictory nature of motion, in spite of its illusionary visibility. This is the briefly stated background of the standard interpretation that by the formulation of his paradoxes *Zeno intended to prove the unreality of motion*. I subscribe to this standard interpretation.

Moreover, there are two camps of thinkers. The shared opinion within the first camp is that Zeno's paradoxes have obtained their solutions, either by mathematical means, or by corrections in their premises. Thinkers within the other camp reject this optimistic opinion. In what follows I'll try to show that the optimistic opinion does not hold water.

3. Criticism of the Paradigmatic Solutions

3.1. Dichotomy

This paradox of Zeno has two versions. According to the first one a runner, starting her quick movement from point A, can never reach a final goal point B. The reason for this conviction is that the runner must firstly reach the middle of the way between A and B, then the middle point of the remaining half of the way, then the middle point of the remaining quarter of the distance to point B, and so on, and so forth. Since space is infinitely divisible, the runner has to pass through infinite number of points in a finite interval of time; and in so far as this is impossible, she will never reach the end point B.

The second version of "Dichotomy" states that the runner can never be set in motion, because before reaching the middle point between A and B, she must have passed through the middle point of the first half of the intended distance, but

before that she must have reached the middle point of the first quarter of the distance, and so on. Thus there is no possibility for the runner to start her running process, which means that a movement from A to B is impossible.

Authors like Nicholas Fearn, for instance, see no difficulty in resolving the first version of "Dichotomy." In the times of Zeno, he contends, people had the false impression that a distance, composed of infinite parts, though diminishing in size, must be infinitely long. But it is known now that the sum S

$$S = 1/2 + 1/4 + \ldots + 1/2^n + \ldots$$

of the dichotomized segments of any distance included between two different points A and B is finite, and equals 1. Thus our runner covers a finite distance in a finite interval of time, and this is all.[4]

The first version of "Dichotomy" cannot be resolved, however, in the suggested way. What Zeno seems to have adduced as an aporetical argument is not the claim about the infinite magnitude of the sum S, notwithstanding whether he believed in that, or not. His argument is that the runner is not able to *actually* pass through an *infinite* number of spatial points in a finite interval of time. And exactly this impossibility implies the impossibility of motion, and hence, its non-reality.

The same reasoning is valid for the second version of "Dichotomy."

As it seems, the paradox could not be obviated by leaving its ontological background intact. Its central assumption is that space is a dense set of points, i.e. it is a continuum. A negation of this assumption is the claim that space is a discrete set of elements, or in other words, that its deep structure is a grain structure, that it is comprised of specific and further indivisible spatial atoms. If this speculation were true, even space as a whole be accepted as infinite, each segment within it should consist of a finite set of spatial atoms. Such an ontological premise, in combination with additional presuppositions, could probably lead to a solution of "Dichotomy." Well, but if we take this speculation seriously, then we have to know what such spatial atoms are by nature and in size. And we still lack such knowledge. Spatial atoms could not be the well known physical atoms, since they also have a spatial structure, expressed by the distances between their nuclei and the orbiting electrons. There are also authors who attract the ontology of quantum mechanics. But this step can hardly be of any help either, since the quantum world exhibits complexities of its own. For example, we have no evidence, and can have no evidence in principle, how a free quantum particle 'moves' from point A

---

[4] See the third essay, "Zeno and the Tortoise," in Nicholas Fearn, *Zeno and the Tortoise. How to think like a Philosopher* (New York: Grove Press, 2001).

to point B, and for all we know, it could realize its 'motion' in many different ways, each bearing its own probability for realization.

The ancient Aristotelian solution, making difference between actual and potential infinity, has certainly a heuristical merit (to be elaborated further by Henri Bergson, as we shall see in 3.3), but offers no clear solution, too. This is the reason for Hegel to agree with Bayle's judgment that Aristotle's answer to "Dichotomy" is, uttered in French, "*pitoyable*."[5]

3.2. Achilles and the Tortoise

Let us imagine now that our hero is the legendary Achilles, who starts his quick run in a race with a slowly moving tortoise to be found 10 meters ahead of him. The curious conclusion in this paradox of Zeno is that the fleet-footed Achilles will never be able to overtake the tortoise in the running race – a fact that obviously contradicts our everyday experience. And it is just through this curious conclusion that the illusionary phenomenon of motion was meant to be proved once again. How this conclusion is made?

If we accept that our hero runs with a speed $v = 1$ m/s (one meter per second), and the tortoise moves ahead with a speed $u = 0, 01$ m/s (one centimeter per second), after the first second from the beginning of the race Achilles is to be found one meter after the starting point, and 9, 01 m behind the tortoise. After two seconds he shall be 8, 02 m behind the tortoise, then 7, 03 m behind it, etc. Although the distance between the two competitors is constantly diminishing, Achilles shall always be *behind* the tortoise, because during each interval of time in which he manages to reach the point where the tortoise was found in front of him, the slow animal will manage to pass a new distance ahead of him. Thus Achilles will never be able to catch up with the tortoise.

It is worth noticing that this paradox could be transformed into the first one, i.e. into "Dichotomy." If our coordinate system is not attached to the earth, but to the moving tortoise, then Achilles ought to cover the distance between his starting point and the immovable tortoise, a distance between two fixed points, A and B. This transformation is possible, because of the equivalent character of the two coordinate systems attached to two inertial frames of reference. This dodge provides no solution to "Achilles and the tortoise," however, unless we possessed a plausible solution to "Dichotomy," and this is not the case.

A "strides solution" is often put to the fore. In our case this suggestion for a solution takes into account that Achilles' stride per second is hundred times longer

---

5 Georg Wilhelm Friedrich Hegel, *Lectures on the History of Philosophy, Vol. I.* (London: Kegan Paul, Trench, Trübner & Co., 1892), 269.

than that of the tortoise. So, ten seconds after the beginning of the race, Achilles shall be 10 m after his starting point, while the tortoise – 10, 1 m after it. After one more second the slow animal shall be 10, 11 m after Achilles' starting point, but Achilles himself – 11 m after it, which would mean that he has overtaken his competitor, and is already 0, 89 m ahead of her. This commonsensical 'solution,' however, walks past the gist of the paradox, that in order to cover the 11 centimeters distance to the tortoise moving ahead of him, Achilles must accomplish infinite acts of crossing over the always remaining spatial intervals separating his body from that of the moving tortoise for a finite interval of time, less than a second.

It could be also contended that the considered paradox has a mathematical solution, resembling the analogous 'solution' to "Dichotomy." Let the initial distance between Achilles and the tortoise is indicated by d, the speed of the running Achilles by v, and that of the tortoise by u. The time needed for the swift-footed hero to reach the first position of the tortoise is $t_1 = d/v$. The time needed for him to reach the second position of the animal, which in the meantime has moved a distance ut_1, is $t_2 = ut_1/v$, the next third time for reaching the third position of the tortoise is $t_3 = ut_2/v = t_1u^2/v^2$, and so on, and so forth. Thus the time needed for Achilles to reach the n-th position of the tortoise is $t_n = (u/v)^{n-1}t_1$. The expression for the sum of the infinite row of time intervals for reaching the ever shifting ahead tortoise's positions is

$$T = \sum_{n=1-\infty} t_n = \sum_{n=1-\infty} (u/v)^{n-1}t_1.$$

This infinite row is a geometrical progression with a multiplier $u/v < 1$, and it is easily obtained that

$$T = d/(v - u).$$

This result means that our running hero can come up with his slow competitor in a finite interval of time that is as close to t_1, as v is greater than u. This result completely agrees with everyday experience, but still can hardly be taken to be a solution of the paradox under consideration. And this is so, because, as it seems, Zeno's intention was not to deny that Achilles is able to catch up with the tortoise in a finite period of time, but that just within this finite period of time he can never actualize an infinite number of crossings of the spatial segments that separate him from the moving tortoise, no matter how a slow 'runner' she is.

3.3. The Arrow

Probably, by this paradox Zeno wanted to show the contradictory nature of motion, not only when it is thought to be a process of transition through

continuous space during the time flow of a finite time interval, but also when it is accepted to be a consecutive change of spatial places, which a moving body occupies in different fixed moments of time. By contrast with the former two cases, "The Arrow" is a paradox accepting motion to be realized not by virtue of the hypothesis about continuous time, but on the basis of the assumption that time is a sequence of discrete moments.

Let us imagine the flight of a swift arrow, and let us also accept that time is a sequence of constantly changing indivisible moments, a permanent sequence of 'nows' (of present moments). Within an arbitrary moment 'now,' the arrow has to be immovable, since if it were in motion, the fixed moment 'now' should be divisible into parts, each corresponding to the places in space, occupied by the arrow. But this conclusion contradicts our premise that the moment 'now' is further indivisible, being the smallest discrete interval of time. So, the time of the flight of the arrow is comprised just by such 'nows,' it is a sequence of discrete time intervals, and within every such 'atom' of time the arrow occupies a fixed spatial volume, which is the place of the arrow corresponding to each specific 'now.' But it follows from here that the arrow is not flying at all, because it is at rest within each 'atom' of time, and a sequence of states of rest can never produce a state of motion.

In order an exit from this aporia to be found, that saves motion as a real phenomenon, some philosophers seek a refuge in dialectics. A dialectical solution to "The Arrow" is expected to be even universal to all paradoxes of motion as well, since this solution turns the paradoxical conclusions, traditionally taken to be a weak point in the philosophical defense of the reality of motion, into an argument in its favour. This transformation is based on evaluative change of the logical contradiction, from a negative into a positive feature explicated by the phenomenon of motion. And it was just "The Arrow" paradox that has given rise to the dialectical paradigmatic solution, or DPS for short, prompted by dialectical reasoning:

(DPS) In every instant the flying arrow *is* found, *and is not* found in a definite place.

The dialectical view accepts the truth of the phenomenon of motion together with its contradictory character. And if motion has to be treated in this way, it should be also claimed that it is *something more* than its standard trajectory presentation through a mathematical function of the spatial position of a moving body defined on the time variable. This is so, because the standard mathematical presentation of motion, being formal and thus a non-contradictory one, presupposes that a moving body has always a strict position in space

corresponding to every instant from the duration of the process of motion. In this way, the standard mathematical presentation describes only *the effect of motion, but is not a presentation of its nature.* According to the dialectical treatment motion is *contradictory in itself.*

> In order to get movement into the picture, according to dialectic, we must recognize *both* that the body is at that place *and* that, in the same instant, it is also ceasing to be so. For our description needs to capture the fact not only that the body *is* where it is, but also that it is *moving* – hence in a process of change and becoming. For this contradiction is essential. As Hegel (…) says, something moves not because at one moment it is here and at another there, but because at one and the same moment it is here and not here.[6]

So, for a genuine (Hegelian and Marxist) dialectician motion (and more generally every change) is, in Hegel's words, an "existent contradiction," and this is the nature of motion, which in no way could be captured by pure mathematical or formal logical presentations. But can the dialectical approach, resulting in its paradigmatic claim that at every instant the flying arrow occupies and does not occupy a definite volume of space, be accepted as a resolution to Zeno's paradoxes?

I pose this question seriously, so I don't expect the probably correct, but trivial answer that dialecticians would reply with "yes," and non-dialecticians – with "no." What a philosopher cherishes above all in accepting a claim as a solution to a paradox is that claim to be grounded on a sound argumentation. This means that if behind the DPS stands a consistent argumentation produced in a proper dialectical pattern, then one must accept DPS as (at least a feasible) solution to Zeno's paradoxes, even if she is not an adherent to dialectics. But is this the case with DPS?

My answer is "no." Although DPS rests on a dialectical formulation, it still lacks an appropriate dialectical argumentation. The notion of contradiction is central for dialectics. It results in the unity and the struggle of opposites. Moreover, the gist of the dialectical approach is the explanation of the dynamical phenomena in nature and the development of social processes through *solutions of the contradictions leading to some new state of affairs*. The latter is always an outcome from the struggle of the former opposites, and is expressed by a claim about *synthesis of a thesis and an anti-thesis*. But this well elaborated dialectical scheme is hardly applicable to the "Arrow paradox," i.e. to the paradox of mechanical motion. Within the phenomenon of mechanical motion the combating opposites are not clearly differentiated. The involvement of the abstract concepts of continuity and discontinuity for this purpose is still

---

[6] Sean Sayers, "Contradiction and Dialectic," *Science & Society* 55, 1 (1991): 87.

insufficient for a clear picture of opposites in a struggle, and the realization of a synthesis as a solution to the alleged contradiction is still more unclear.

DPS remains a very general statement, dependant on how the paradigmatic dialectical formula "A *and* non-A" is being interpreted, while there is no unanimously accepted interpretation among philosophers and logicians. Thus DPS can pretend for the most to be some conceptual framework for understanding the "Arrow paradox," but not a proper solution to it.

In his *Creative Evolution*, Henri Bergson declares to have surmounted Zeno's paradoxes of motion.

> Take the flying arrow. At every moment, says Zeno, it is motionless… Yes, if we suppose that the arrow can ever be in a point of its course. Yes again, if the arrow, which is moving, ever coincides with a position, which is motionless. *But the arrow never is in any point of its course.* The most we can say is that it might be there, in this sense, that it passes there and might stop there. It is true that if it did stop there, it would be at rest there, and at this point it is no longer movement that we should have to do with. The truth is that if the arrow leaves the point A to fall down at the point B, its movement AB is as simple, as indecomposable, in so far as it is movement, as the tension of the bow that shoots it… Suppose an elastic stretched from A to B, could you divide its extension? The course of the arrow is this very extension; it is equally simple and equally undivided. It is a single and unique bound. You fix a point C in the interval passed, and say that at a certain moment the arrow was in C. If it had been there, it would have been stopped there, and you would no longer have had a flight from A to B, but two flights, one from A to C and the other from C to B, with an interval of rest. A single movement is entirely, by the hypothesis, a movement between two stops; if there are intermediate stops, it is no longer a single movement.[7]

The key point in this quotation is the bold claim that "the arrow never is in any point of its course." If this claim was not taken seriously, then the other metaphorical contentions of Henri Bergson to the effect that the course of the arrow is an "extension" resembling that of stretched elastic from point A to point B, and that the motion of the arrow represents a simple and indivisible act, would sound no more than curious assertions. Probably Bergson has learned well the Aristotle's lesson that in considering Zeno's paradoxes one must give up operating with actual infinity and thus must not direct her attention at the trajectory of a body that has already ceased its motion, since the line of the trajectory is a dense and actually infinite set of spatial points. The phenomenon of motion should not be explained through its result, when a moving body has already stopped to move,

---

[7] Henri Bergson, *Creative Evolution* (New York: Henry Holt and Company, 1911), 308-309. My italics.

but should be construed as an "extension," as an indivisible bound through space. So, the claim that an arrow starting from point A and ending its flight at point B has passed through point C as well, has no proper meaning, unless the arrow has stopped in C, is motionless in C, and then has resumed its flight from C to B. Otherwise we cannot meaningfully assert for a body in motion that it is in point C at a definite moment of time.

Bergson pretends also that his conception about the phenomenon of motion provides a simple solution to "Achilles and the tortoise" paradox.

> When Achilles pursues the tortoise, each of his steps must be treated as indivisible, and so must each step of the tortoise. After a certain number of steps, Achilles will have overtaken the tortoise. There is nothing more simple.[8]

Can we accept Bergson's exhortation that "there is nothing more simple"? I think that the answer is "no," at least for two reasons. His suggested solution is but the already considered in 3.2 "strides solution," and we saw that it does not meat the conceptual challenge of the paradox. At that, his "simple" solution is not quite consistent with his own view of the nature of motion. Indeed, if Achilles has undertaken a swift run, then, as Bergson clearly insists, his body should be involved in an indivisible act of motion. But why then Achilles' steps should be considered separately from one another, as if the fleet-footed hero stops and resumes his dash with every step of him?

Let us turn back to the central idea of Bergson's conception of motion. It is expressed by the claim that a flying arrow is never found in any point of its course at any instant of the duration of its flight.

What does this claim mean, and what is its explanatory import for the solution of "The arrow" paradox?

At first glance, Bergson's central claim resembles the dialectical solution expressed by the DPS. For in both attempts at solving the paradox it is asserted that at every instant the arrow does not occupy a definite place in space. We have come to the conclusion that DPS is not a proper solution to "The arrow" paradox, but a general conceptual framework for its construal. The case with Bergson's central claim is even worse, since Bergson does not even have the potential of the dialectical scheme at his disposal.

As for the explanatory import of Bergson's claim one may say that in its quality of a general assumption it could have the only pretension "to save the phenomenon" of motion, and not to explain its possibility and hence its reality. So,

---

[8] Bergson, *Creative Evolution*, 311.

the proposed solution by Bergson to Zeno's paradoxes can attract, on its part, the old Bayle's qualification: "pitoyable" (see 3.1).

4. Back to Parmenides' World

If we agree together with eleatic philosophers that, because of the explicated paradoxes, motion is a phenomenal illusion and is thus deprived of reality, we shall face no need to really solve the paradoxes. However, this agreement would be a conceptual victory over the opponents to eleatic philosophy, but not over Zeno's paradoxes. Once taken out of Pandora's philosophical box, Zeno's paradoxes may not require proper solutions within the context of Parmenides' ontological view, *but they still require some serious philosophical answer*. This is the answer to the following problem:

> (P) If the real world is one and unchangeable, how various changes, and motions among them, are permanently present in human experience?

Even an ardent proponent to eleatic philosophy cannot merely say, "don't worry, they all are illusions," because she will beg the question. If visible motions are inextirpable from human experience one should either say that we perceive an illusionary world, or give an explanation how motion is possible to be perceived in an unchangeable world. The first option seems to be unacceptable within the framework of rational philosophy, being probably in harmony with some eastern worldviews. So, I shall direct my attention to the second option. And this clearly means an answer to (P) to be provided.

The other way round is to accept together with Zeno's critics that visible motions are quite real phenomena, so doubting their possibility is a ridiculous philosophical fashion. Motions are present in human experience merely because of their real existence which is adequately perceived. However, we must provide then a plausible solution to Zeno's paradoxes. This is the enterprise we have considered so far, and as we have seen, it has not come to a successful end.

Ancient heuristic ideas underlie theoretical thinking for centuries. Thus the atomistic idea about the structure of material bodies has been transformed (by changing a variety of theoretical garments) into the contemporary quantum mechanical picture of the world. But what about the eleatic idea of the one and unchangeable world, does it have a contemporary theoretical counterpart? The answer to this question is positive. The contemporary theoretical elaboration of this ancient idea is the conception usually known under the name "block universe." This conception bears rather a psychologically repelling name. I shall not use this name in what follows for this reason. But let us firstly see in a brief comment how the conception has come into being.

The contemporary conception of the "unchangeable world" is a theoretically elaborated consequence from the special theory of relativity. It is well known that, according to this theory, the plain notion of simultaneity has a relative status. This means that events that are simultaneous for one observer do not take place simultaneously for another observer whose inertial system is in motion with respect to the first one. A given event that will take place in a future moment (or has already taken place in a past moment) with respect to the first observer might be an event belonging to the present moment with respect to the second observer.

Let me give an example. Imagine that Mary is sitting at a table while she is accidentally pushing her glass of water over the edge of the table. Whether the glass *will be* broken or not when it reaches the floor after two seconds, is a *future* event for her. But it might be the case that for John, a second observer, being in a relative motion (with a great enough velocity) with respect to Mary, the non-broken glass, already lying on the floor, is an event belonging to the three dimensional space of his *present* events. Thus *one and the same event* – a glass on the floor with spilt water around it – belongs to a future moment for Mary *and* to the present moment for John.[9]

The considered event belongs to Mary's future. She does not yet know whether the glass will be broken, or not, when it will reach the floor, and so the event has not yet come into being for her. But for John this same event really exists, since it belongs to his present. We thus see that due to the relativity of simultaneity different events, being past or future events for some observers may also appear to be present events for other observers. None of the observers, however, has a privileged position in the four-dimensional world of the special theory of relativity; there is no 'absolute' three-dimensional space within the four-dimensional *space-time* from the relativistic picture of the world. Past and future events for some observers are present, and to this effect existent events, for other observers. There is no absolute past, present, and future, these tense divisions are meaningful only with respect to concrete observers. And since none of them is privileged with respect to the others, we come to the conclusion that all events in the four-dimensional space-time have one and the same ontological status, they are equally real. But if so, the four-dimensional space-time is actually given with all its events. This further means that it is a 'static' world, a world that does not change, because *the time dimension is actually present as a constituent of this*

---

[9] For a lucid explanation why such things happen in the world of Minkowski, represented in the special theory of relativity by a four-dimensional pseudo-Euclidean space, see for example Roger Penrose, *The Emperor's New Mind* (New York: Oxford University Press, 1989), ch.5.

same world, and it itself cannot undergo any changes, for the realization of which an additional (and global) time dimension would be needed. We thus see that the *actual presence* (one cannot say 'existence,' since this concept presupposes some time duration outside the time dimension within the four-dimensional world) *of the space-time* could be interpreted as a contemporary theoretical renovation of the ancient eleatic idea of one and unchangeable world.

In case that the if-clause of (P) is taken to be valid, then how visible motions are possible? In other words, why do we permanently perceive the phenomenon of motion, if the world is unchangeable 'as a whole'?

In order an answer of (P) to be outlined, attention must be paid to the fact that the concept of motion is totally dependant on the concept of time. Motion is change of spatial positions through time. Spatial positions are directly perceivable, but what about time? Time was taken to be a dimension constituting, together with the other three spatial dimensions, a four-dimensional world. Approaching a solution to (P) presupposes then an answer to the following puzzle:

(F) Why do we perceive that time flows, if it does not do so?

As Paul Davies puts it:

Elucidating the mysterious flux would, more than anything else, help unravel the deepest of all scientific enigmas – the nature of the human self. Until we have a firm understanding of the flow of time, or incontrovertible evidence that it is indeed an illusion, then we will not know who we are, or what part we are playing in the great cosmic drama.[10]

One should not assess this avowal of Paul Davies as a pathetic ornament to his theoretical reflections. (F) is really a puzzle about the phenomenal flow of time, which has no generally accepted answer. Philosophers and physicists are divided as to whether the flow of time is a specific process within the universe bestowed with some kind of objectivity, or it is mind-dependent, and emerging because of the nature of our consciousness. (A putative objectivity of the time flux must not be confused with the arrow of time, since time can have a direction without any process of flowing.) Anyhow, accepting the validity of the conception about an unchangeable world leads undoubtedly to the claim that *the flow of time is mind-dependent*. There is no "mysterious time flux," because every observer feels and measures time by himself within a given system of reference. In other words, according to relativity theory, each observer has his own time; time intervals coincide only for subjects which are in rest with respect to each other.

---

[10] Paul Davies, *About Time. Einstein's Unfinished Revolution* (London: Penguin Books, 1995), 278.

The so called twin paradox (or clocks paradox) is a convincing example for the relativity of time intervals measured by observers found to be in relative motion.

The contemporary resurrection of the Parmenidean world leads to a variety of deep theoretical problems concerning the nature of time and of human consciousness. Thus the consideration of (P) in the context of unveiling the puzzle (F) leads to the claim about the mind-dependency of the flow of time. This claim is in harmony with *the B-theory, or the static conception of time*.

Curious as it might seem, long before this claim (as a corollary of special relativity) to be given meaning to, St. Augustine has come to a similar conclusion in his *Confessions*:

> From this it appears to me that time is nothing other than extendedness; but extendedness of what I do not know. This is a marvel to me. The extendedness may be of the mind itself[11]… It is in you, O mind of mine, that I measure the periods of time.[12]

Now we come to the question how further to construe the claim that the flow of time is mind-dependent. The flow of time is associated with the continuous 'passage' of the present moment, the moment 'now,' in human experience. This is the plain feeling of an evolving three-dimensional world around us together with the conviction that only the present, being directly perceivable, possesses a real existence, while the past does not already exist and the future does not still exist. Let us recall, however, that in a Parmenidean world (or according to the B-theory of time) past, present, and future events are equally real. How then we experience the feeling that time flows, if the moment 'now' has no privileged ontological status?

This key question has not yet obtained a plausible answer. But a general path to it may be cut. Let me use for this purpose the following metaphorical picture drawn by Barry Dainton:

> Imagine walking up to find yourself in a strange place. You are sitting in a field of grass, next to a lamp that illuminates the surrounding area. There is complete silence. As you look around, you can see nothing whatsoever. Apart from the small patch of grass illuminated by the lamp there is darkness everywhere. Not surprisingly, you conclude that you are alone. You could not be more wrong. A few yards to your right there is another lamp, and another person waking up to find themselves surrounded by total darkness; likewise to your left. In fact, you are in a line of people stretching for many miles in either direction, all of whom

---

[11] Aurelius Augustine, *Confessions*, Book 11, ch.26, 33.
[12] Augustine, *Confessions*, ch.27, 36.

are sitting in their own small pools of light, all of whom are alarmed to find themselves alone in a strange place.

Why is it that nobody can see anyone else? The answer lies with the strange form of light emitted by the lamps, which only extends a few feet before dying away. According to the B-theorist, *we find ourselves in an analogous position in time. What stretches only a short distance is not light through space but consciousness over time: the temporal span of direct awareness is very brief. And as in the analogous spatial case, the fact that at any given time we are not aware of experiences occurring at other times does not mean that these experiences are not there.*[13]

"The temporal span of direct awareness" is the brief span of the instant 'now.' Within this instant we are aware of our present. Thus Barry Dainton draws a substantial analogy between a process of passage from a small patch of illuminated area to another one, and the process of change of the instance 'now' in our perception of the present state of the world. As if our consciousness sheds 'a moving ray of light' over our own world-line within space-time, i.e. over very small fragments of our history. These illuminated fragments constantly supersede one another, as if the thin ray of our consciousness 'is constantly moving' along our world-line in space-time, and thus is constantly extracting the 'now' instances out of it, making us to be aware of our three-dimensional presents. The non-physical 'motion' of the 'illuminating ray' is a yet unknown process lying deep in the nature of human consciousness (probably due to specific quantum features, restricting the scope of phenomenal appearances). This is why Paul Davies declares, as we have seen, that "elucidating the mysterious [time] flux would, more than anything else, help unravel the deepest of all scientific enigmas – the nature of the human self" and would help us know "who we are, or what part we are playing in the great cosmic drama."

We can thus say that the human mode of being in the world is the consecutive grasping of three-dimensional space slices from the four-dimensional space-time, corresponding to the 'now' moments from the world line (more exactly from the world-tube) of every conscious observer. And it is exactly this perceptual splitting of the unified space-time continuum into space *and* time, or, in other words, the way in which space-time is presented to our sensuous intuition as *space* and *time*, which is responsible for the metrical and topological qualities of space and time *as they appear to us*, as if they are objectively and

---

[13] Barry Dainton, *Time and Space* (Durham: Acumen Publishing Limited, 2001), 29-30. My italics.

separately existing entities. Thus we experience the continuous character of space and time, and further speculate about their probable discontinuous character.

This is the explanation for the appearance of Zeno's paradoxes. *They stem out as a result of the classical ontological picture about the existence of space and time as separate ontological entities that can be either continuous or discrete together, or separately.* Each of these formal assumptions results in a paradox of motion to be viewed as a change of spatial positions through time. So, they appear in their form of *aporiae*, of paradoxical consequences without an exit. They have either no proper ontological solution, or inspire dialectical attempts that are mostly promises for a solution without further clarification (see 3.3).

It can be easily seen that Zeno's paradoxes are precursors of Sextus Empiricus *aporiae* of the non-existence of time, since it is neither divisible, nor indivisible,[14] and also of St. Augustine's paradox expressed by the question "how do we measure present time since it has no extension?"[15] The origin of these paradoxes, as well as of Zeno's paradoxes, is one and the same: the classical ontological picture of space and time, drawn by imposing our phenomenal intuitions of space and time onto the world as being separately existing objective entities.

5. Conclusion

An easy way to get rid of Zeno's paradoxes is to agree with his critics that visible motions are quite real phenomena, and doubting their possibility is a ridiculous sophistical fashion. But if so, Zeno's paradoxes are in need of a plausible solution. There is no unanimous agreement among philosophers whether such a solution has been attained. It could be added, moreover, that their attempted paradigmatic solutions walk past their goal, which was demonstrated in section 3.

If we agree with Parmenides' disciples that the world is one and unchangeable and so motions are phenomenal illusions, as Zeno himself seems to do, then we need not propose direct solutions to Zeno's paradoxes. In this case, however, the problem arises how motions are permanently present in human experience, provided we live in a Parmenidean world (see (P) in section 4). Motion is a consecutive change of spatial positions through time, so the concept of motion is strongly dependent on the concept of time. But there is no absolute time in the contemporary relativistic picture of the world, drawn over the scheme of a four-dimensional space-time. Thus (P) is reduced to the puzzle (F) asking why do we perceive that time flows, if it does not do so.

---

[14] Sextus Empiricus, *Against the Professors*, ch.10, 169-247.
[15] Augustine, *Confessions*, Book 11, ch. 21, 27.

In the end, an interpretation for the emergence of Zeno's paradoxes is provided, based on the ascribed properties of continuity and/or discontinuity to space and time, as if they are separate ontological entities, which could possess such features.