PHILOSOPHY OF SPACE, TIME AND MOTION

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Motion comprises movement and pause in alternate succession, of which movement part is instantaneous and pause part constitutes time. The concept has been developed through analysis of Zeno's paradoxes of motion, which implies that space is discrete and time is a continuum. The concept of space as a continuum is philosophically self contradictory, because diversity, the key feature to the existence of the universe, can appear and exist only at the expense of continuity of property at different parts of space. Space is neither continuous nor void. Space is discrete and a structured configuration of almost infinite number of minute space cells.

Introduction

Mankind is studying Nature since the dawn of civilization. However, modern physics started its journey with the study of falling bodies by Galileo. Since then, physics is striving and inching forward towards its goal to formulate the GUT (Grand Unified Theory). At present two separate theories 'General Theory of Relativity' and 'Quantum Mechanics' are applied to describe the Nature in macro and micro scale respectively. However, these two theories are not compatible to each other. To quote Hawking1, 'Unfortunately, however, these two theories are known to be inconsistent with each other – they cannot both be correct.' (A Brief History of Time, Page 13). To my mind, the root of the inconsistencies lies in the incomprehensive understanding of the philosophy of space, time and motion, which are the basics and constitute the starting point of the journey. Since the third decade of twentieth century, physicists are relying extensively on mathematical modeling, neglecting the physical aspect of the theory and most of the modern concepts cannot be physically demonstrated. This paper attempts to portray a new philosophy of space, time and motion, which may pave the way to bridge the contradictions between the two theories.

Concept of Motion

Newton analyzed the results of various experiments, terrestrial observations and theories proposed by his predecessors and formalized the laws of motion with the concept of state of rest or motion. Motions may be classified under the following three categories:

- Intermittent motion, like that of the second's hand in an electronic watch, when the second's hand makes a move every second. Intermittent motion comprises two stages, namely, movement and pause.
- Uniform motion, like that of the second's hand in a sweep type electronic watch. Uniform motion covers equal distances in equal interval of time, continuously moving without stoppage.
- Uniformly or non – uniformly accelerated / decelerated motion, like that of the starting / stopping of cars.

Before analyzing further on the concept of motion, let us have a look at the Zeno's paradoxes of motion, formulated by the Greek philosopher Zeno of Elea about 2500 years back. W. C. Salmon2 in his book, Zeno's Paradoxes, mentioned that the exact formulation of the paradoxes in Zeno's words is not available and at present the primary source is Aristotle. Out of those recorded paradoxes, four of the most famous and known paradoxes relating to motion are 'Achilles and the tortoise, the

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dichotomy argument, an arrow in flight and the stadium’. The first three paradoxes as paraphrased in Aristotle's Physics are indicated below.

- **Achilles and the Tortoise**
  
  In a race, the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead. (Aristotle Physics VI:9, 239b15)

- **The Dichotomy Paradox**
  
  That which is in locomotion must arrive at the half-way stage before it arrives at the goal. (Aristotle Physics VI:9, 239b15)

- **The Arrow Paradox**
  
  If everything when it occupies an equal space is at rest, and if that which is in locomotion is always occupying such a space at any moment, the flying arrow is therefore motionless”. (Aristotle, Physics VI:9, 239b5)

These paradoxes are extensively debated since the early days of Aristotle and an enormous amount of literature is available. The book, Zeno's Paradoxes by W. C. Salmon, comprises articles by some great proponents on the subject. The suggested solutions centre around the following basic concepts.

- Finite sum of an infinite GP series in regression and concept of infinity machine to complete a super-task in finite time.
- Atomistic nature of space and time.
- Cantorean concept of linear continuum.

My suggested solution is different to those mentioned above. Before going to that let me note my observations on the suggested solutions quoted above. The basic spirit of Zeno's paradoxes vis-à-vis the various suggested solutions has been aptly depicted by W. C. Salmon in the introduction of his book "Zeno's Paradoxes". To quote from page 16, "It would be a mistake to suppose that Zeno's paradoxes are fully resolved if it is possible to give a logically possible characterization of the continuum. There is, in addition to the logical question, also a semantical one. Zeno's paradoxes deal with physical extension, physical duration, physical process and physical motion. These problems are not answered merely by developing a consistent system of pure mathematics. It is also necessary to show how the abstract mathematical system can be used for the description of the concrete physical reality. Whitehead, for one, does not claim Cantor's theory of continuum is inconsistent; he does claim that it is inadequate for the description of physical process ..."

It is worthwhile to note that Salmon has repeatedly emphasized the word 'physical', which is the crux of the problem.

**Finite Sum of an Infinite GP Series and Infinity Machine**

Aristotle mentioned that, as the distance to be covered decreased, the time required to cover the distance also decreased and it became smaller and smaller. So Achilles would eventually overtake the tortoise and also reach his goal. Mathematicians developed the method of computing the sum of a series with infinite terms and showed that the sum of an infinite GP series with diminishing terms was finite. Hence, proponents of this view argued that Achilles would eventually meet the tortoise and reach his goal as well. But such solutions do not answer how to physically complete an infinite series of tasks. To quote Max Black, "This kind of mathematical solution has behind it the authority of Descartes and Peirce and Whitehead – to mention no lesser names – yet I cannot see that it goes to the heart of the matter. It tells us, correctly, when and where Achilles and tortoise will meet, if they meet; but it fails to show that Zeno was wrong in claiming that they could not meet. " (Page 70, Zeno's Paradoxes by W C Salmon). Black also mentioned 'that the notion of infinite series of acts is self-contradictory.' Wisdom also corroborated Black's ideas and argued that it was not Zeno's conclusion which was wrong but it was its premiss which was wrong. He mentioned, 'A physical point, unlike a mathematical point has some size, thought his may be as small as we please. ...... Hence, an infinite geometric series is inapplicable to a physical distance i.e. a physical race cannot be described by repeated bisection, or Zeno's premiss is false.' (Page 88, Zeno's Paradoxes by W C Salmon). This idea is equivalent to the atomistic characterization of space, which has also certain lacunae as explained later in 2.6. The debate on feasibility of finishing a super-task by Thomson and Benacerraf is rather philosophical than physical and lacks the emphasis on physical aspect which is the crux of Zeno's paradoxes. Besides, illustration with infinity machine suffers from a significant difference in physical aspect. While Achilles' tasks get smaller and smaller, the effort necessary by the infinity machine becomes greater and greater, the task remaining the same.

It will be evident that these suggested solutions do not provide the answer to the physical aspect of Achilles
and Dichotomy paradoxes. Besides, these suggested methods take recourse to the time factor to arrive at a solution. To my mind introduction of time aspect is philosophically inconsistent. If an event gets completed due to lapse of time, then time is treated as a causal agent to make an event happen. As if time is making Achilles bound to complete his infinite tasks within its own domain. Can time only be a causal agent to make an event happen? The time factor is brought into play due to the use of words like 'never, always' by Aristotle in paraphrasing the paradoxes. The paradoxes in the words of Zeno are not available. Let the paradoxes be paraphrased as:

- In a race, the quickest runner cannot overtake the slowest, since everytime the pursuer reaches the point whence the pursued started, pursued holds a lead.
- That which is in locomotion must be at the halfway to arrive at the goal.

The paradoxes as paraphrased above do not involve the time aspect of the events, yet offer the simple and stinging paradoxical situations.

**Atomistic Nature of Space and Time**

The system, ‘space – time’ can be discrete if:

- Space is discrete
- Time is discrete
- Both space and time are discrete

Space is a function of length. Hence length is discrete if space is discrete. Let the length and time be represented by \( s \) and \( t \) respectively. \( s' \) and \( t' \) represent the indivisible quantum of length and time. Velocity in general is defined as, \( v = \frac{s}{t} \).

In the first case space is discrete, then \( v = \frac{s'}{t} \). As \( s' \) is a constant quantity, different velocity will mean crossing this quantum length at different span of time, implying stages within the quantum length, which is contradictory to the basic definition.

In the second case, time is discrete and space is a continuum. This does not provide solution to the dichotomy problem as space is infinitely divisible and any movement from one point to the other will require infinite number of steps and the arguments on feasibility to complete an infinite number of acts will arise. Besides, quantization of time leads to the following implication:

- Let \( t' \) be the time quanta, \( h \) be the head start and \( v_t \) and \( v_a \) be the velocity of the tortoise and Achilles respectively. Hence, the length run by Achilles in time quanta is \( s' \). The congruence \( h \equiv 0 \pmod{(t', v_a)} \) may or may not be true. If not, then Achilles cannot be at the starting point of the tortoise and the formulation of the paradox becomes irrelevant. In fact, a body, moving with velocity \( v \), may or may not reach a desired point at a distance \( s \) in the space continuum, if the congruence, \( s \equiv 0 \pmod{(t', v_a)} \) is true or not. Hence, to reach a desired point, one has to adjust the velocity before he starts to move.

In the third case, both space and time are discrete. Then, \( v = \frac{s'}{t'} \). As \( s' \) and \( t' \) are both constants, velocity becomes an invariant quantity, which in itself is a paradox. In general terms the velocity can be defined as: \( v = x.s' + y.t' \), where \( x \) and \( y \) are positive integers, such that \( y|x \). It implies that velocity less than \( v \) (i.e. \( s' + t' \)) cannot exist in Nature, which is also an absurd proposition. Otherwise, velocity less than \( v \) will imply stages in length quanta. Besides, quantization of space-time leads to the controversy as envisaged by Zeno in the Stadium paradox. To quote Russell, "...... When, then, did B pass C'? It must have been somewhere between the two moments which we supposed consecutive, and therefore the two moments cannot really have been consecutive. It follows that there must be other moments between any two given moments, and therefore that there must be an infinite number of moments in any given interval of time." (Page 53, Zeno's Paradoxes by W C Salmon). However, Adolf Grünbaum in his paper 'Modern Science and Zeno's Paradoxes of Motion' endorsed the view that B did not pass C' at all. He treats this crossing to be a nonevent. To quote Grünbaum, "Hence whether a given spatial vertical alignment qualifies as an event or not depends on the magnitude of the relative velocity of the two rows: If it is two 'jumps', then a vertical alignment need not qualify as an event, whereas it does so qualify when the relative velocity is one 'jump'!" (Page 350 Zeno's Paradoxes by W C Salmon). Following this analogy it may be mentioned that there is relative velocity between Achilles and tortoise. To a spectator at the side of the track, the alignment of Achilles and tortoise is vertical. The situations that arise:

- How the spectator will judge whether the relative velocity is one or two jumps?
- Hence, crossing the tortoise by Achilles may or may not be an event to the spectator.

This is not a physically convincing argument.

**Cantorean Concept of Linear Continuum**

In the concluding part of the book, Zeno's Paradoxes, W C Salmon2 mentioned, "It is the linear continuum, with
its super-denumerable cardinality, its dense ordering, and its absence of gaps, which lies at the foundation of our modern understanding of all of Zeno's paradoxes of plurality and motion. The paradoxes take as their point of departure the supposition that space, time, and physical processes are continua. The resolution of the paradoxes along the lines proposed by Grünbaum rests heavily upon a searching analysis of the ordinal and metrical structure of linear continuum." (Page 368).

Out of all the paradoxes formulated by Zeno, the paradox of plurality is much more fundamental in nature. Its solution automatically solves the others. In simple terms the paradox of plurality can be stated as, if a physical object is divisible then its constituent part must be without physical extension and so collection of those will be devoid of physical extension; otherwise, if the constituent part has physical extension then collection of those will become infinite.

Grünbaum argued that the paradox of pluality can be answered with the Cantorean concept of linear continuum, which is the set-theoretic sum of zero-dimensional subsets. Hence, collection of a super denumerable infinite collection of constituent part without physical extension can define a finite size. This not only solves the Achilles and Dichotomies paradoxes but also the Arrow Paradox, because the arrow can fly even if it is at rest at any instant i.e. the point of time devoid of extension. Thus it also solves the Stadium Paradox as any given interval of time may comprise infinite set of instants.

Here I would like to refer again to what W C Salmon mentioned, "These problems are not answered merely by developing a consistent system of pure mathematics. It is also necessary to show how the abstract mathematical system can be used for the description of the concrete physical reality. Whitehead, for one, does not claim Cantor's theory of continuum is inconsistent; he does claim that it is inadequate for the description of physical process." Leaving aside the question of applicability of the abstract mathematical ideas at physical process, which is relevant and significant, I humbly beg to disagree with Whitehead's view that Cantor's theory of continuum is consistent. This is explained below.

The concept of cardinality in respect to various sets of infinities was introduced by Georg Cantor. The salient points of the concept are:

The number of natural numbers is infinite i.e. the number of members in the set of natural numbers is infinite. Similarly, the set of all integers and fractions i.e. rational numbers, has infinite members. However, there is one-to-one correspondence between the members of each set. Hence, cardinality of both the sets is same. Cantor with the help of a method called 'diagonal slashing' and one-to-one correspondence showed that the cardinality of the set of real numbers (rational and irrational numbers) was more than that of the set of rational numbers. Accordingly, he graded the class of infinities as:

First order of infinity, denoted by the symbol \( \chi_0 \) for the set of rational numbers. Second order of infinity, denoted by the symbol \( \chi_1 \) for the set of real numbers. The cardinality of the set of points in a line segment is same as that of the set of real numbers and the Cantorean concept of linear continuum is based on this.

I beg to differ on this point and submit that there is an omission in the argument regarding the equivalence of cardinality between the set of real numbers and the set of points in a line segment. While the points on a line segment can correspond to irrational numbers, they do not possess the correspondence property to all irrational numbers. This concept of correspondence is demonstrated by physical construction of the length representing the irrational number \( \sqrt{2} \). But, the length representing the irrational number \( 3\sqrt{2} \) cannot be physically constructed, notwithstanding the Greek method of doubling a cube, which is a trial and error process (Page 146, What is Mathematics by R Courant et al), making us assume that such a point exists. This assumption is notional as the point can only be approached more and more closely but cannot be met, like a point on a hyperbola can only approach the axes but cannot meet. It is not possible to construct a cube, which will be twice in volume of a given cube, because, if the length equivalent to \( 3\sqrt{2} \) exists, then the equation \( a^3 + b^3 = c^3 \) must have nontrivial solution in rational numbers, which is not true. While all numbers of the form \( \sqrt{x} \), where \( x \) is a rational number, correspond to specific lengths physically identifiable, the irrational numbers of the form \( 3\sqrt{x} \) are both numerically as well as physically irrational. No point on the number axis can be physically identified, (like that for \( \sqrt{2} \)), which corresponds to the real number \( 3\sqrt{2} \).

Accordingly, the mathematical concept of continuum of real numbers is not applicable to the point set of line segment, whose cardinality is in between first and second order. Hence, Cantorean concept of linear continuum contains gap and is not applicable as solution to Zeno's paradoxes.

**Absence of an Instant Underlying Body's Motion**

Besides the above mentioned concepts, Peter Lynds in his article 'Zeno's Paradoxes ; A Timely Solution'
suggested solution based on the absence of any moment underlying the motion of an object. Peter Lynds basically deals with the Arrow paradox through critical analysis of the present concept and definition of time. He mentions that his proposed solution would also provide solution to the other paradoxes. To quote Lynds, "To return to Zeno's paradoxes, the solution to all of the mentioned paradoxes then, is that there isn't an instant in time underlying the body's motion (if there were, it couldn't be in motion), and as its position is constantly changing no matter how small the time interval, and as such, is at no time determined, it simply doesn't have a determined position. In the case of the Arrow paradox, there isn't an instant in time underlying the arrow's motion at which its volume would occupy just one block of space, and as its position is constantly changing in respect to time as a result, the arrow is never static and motionless ..... " (Paragraph 4c)

Like other academicians, Peter Lynds also puts thrust on time aspect, which is not the proper spirit of Zeno's paradoxes. To my mind, spatial aspect was Zeno's main concern in all the paradoxes, except the Stadium. However, Lynds showed that the concept of static state of an instant is logically inconsistent, because as instant, which is a part of time, has to remain in the same state without any change at two different points of time, which is fallacious. Hence, Lynds' assertion implies that an instant with physical extension (however small it may be) will underlie a spell of motion. This, in effect, results in quantization of time, extension of which may be smaller than any pre-assigned value, which itself is self contradictory. Besides, Lynds' analysis also does not include the characteristics of space i.e. whether space is discrete or not. Hence, the solution is not comprehensive in that respect. The concept of atomistic nature of space and time leads to certain anomalies as explained in 2.6.

Now, let us reexamine the Arrow paradox. It starts as "If everything when it occupies an equal space is at rest...." Obviously the basic premise is spatial and accepted as true. Now let the paradox be put in another way. An object A occupying the space S is at rest at time \( t_0 + \varepsilon \) (as per definition of time as an interval by Lynds). It is again observed at another time \( t_1 + \varepsilon \) and it is also then occupying space S and is at rest. Similarly, at time \( t_3 + \varepsilon \) it is occupying space S, hence it is at rest. Now, can any time \( t_1 + \varepsilon \) be identified when the object does not occupy the space S, so that it may be concluded that the object is not at rest? It may be argued that the reverse condition of the basic premise need not be automatically true. Then it is to be accepted that the definition of the basic premise is incomplete and not true; but the basic premise is accepted as true, hence the conclusion is also true. If the Arrow paradox is paraphrased after obviating the temporal aspect as, "If anything occupying an equal space is at rest, it cannot move" then the question of absence of instant (or precise static instant) underlying the body's motion does not arise.

**Suggested Solution**

It is evident that none of the solutions quoted above is comprehensive. My suggested solution to the paradoxes is somewhat different. The ideas put forward by Russell in 'at-at' theory and the cinematographic view of becoming by Bergson are somewhat similar to my suggested solution. On Arrow paradox Russell wrote : "It is never moving, but in some miraculous way the change of position has to occur between the instants, that is to say, not at any time whatever. This is what M. Bergson calls the cinematographic representation of reality." (Page 51, Zeno’s Paradoxes by W. C. Salmon).

My suggested solution of the paradoxes involves a critical look at the present concept of the motion itself. Since the early days of human civilization motion has been considered as the movement by an object from an initial position to another position requiring some time in the process. This concept implies that the object is at a specific point in space at specific point of time, and that, the movement and time remain like Siamese Twins attached to each other at any conceivable stage of the motion. Now, let us examine Zeno's paradoxes. While mathematics indicates that Achilles should have been trapped in completing an infinite series without end (i.e. the continually diminishing length of head start, which never becomes zero), we physically observe that he actually completes it. As Achilles eventually catches the tortoise, it implies that at certain stage on the race course, without bringing the time into consideration, it can be logically deduced that the remaining head start as per mathematics becomes physically equivalent to zero. This is obviously different from being equal to zero. This can happen only when time and motion are separated from each other somewhat like that in case of intermittent motion i.e. movement and pause occur alternately. However, the movement component will not consume any time, because the arguments noted under 2.5 to 2.8 will come into play for the part. This can be illustrated as shown below. Let an object A move from P to Q as in Fig. 1.

![Figure 1](image-url)
where \( t \) is the duration of pause and \( Q_1, Q_2, Q_3, Q_4 \) are positions at which the pause occurs. Here, the object moves from \( P \) to \( Q \) in the \( 4t \) and its velocity is \( \frac{PQ}{4t} \) in the direction \( PQ \).

The suggested concept of motion leads to the following conclusions:

- Movement from \( P \) to \( Q_1 \), \( Q_1 \) to \( Q_2 \), \( Q_2 \) to \( Q_3 \) etc. does not consume any time. Hence, initially the object \( A \) is present anywhere between \( P \) and \( Q_1 \) so far its position is concerned. This answers the Dichotomy as well as arrow paradox. Similarly, after the first pause at \( Q_1 \) it is present anywhere between \( Q_1 \) and \( Q_2 \) and so on. Similarly at the end of the movement the object is present anywhere between \( Q_4 \) to \( Q \). This answers the 'Achilles and the tortoise' paradox because Achilles catches the tortoise one stage later, where the head start reduces to that, which is equal to the distance between two consecutive pauses.

- If the magnitude of \( t \) remains constant in a specific case for a particular object it will appear to be in the state of uniform motion. If the magnitude decreases / increases, the result will be either accelerated / decelerated motion.

- As no time is consumed to move from \( Q_1 \) to \( Q_2 \), \( Q_2 \) to \( Q_3 \) etc. \( \Sigma t \) (sum of pauses) will appear to be continuous.

- The distance between \( P \) to \( Q_1 \), \( Q_1 \) to \( Q_2 \), \( Q_2 \) to \( Q_3 \) etc. is the fundamental unit of length as defined by the NATURE and remains unchanged for all types of motion. Any physical quantity relating to the length, area and volume is an integral multiple of this length.

- Motion is the manifestation of the NATURE's attribute to be omnipresent within the fundamental length. Force provides direction to this characteristic of being omnipresent, which then appears as motion in the direction of the force applied.

- The duration of the pause at \( Q_1, Q_2, Q_3, Q_4 \) is perceived as time, and is directly proportional to the mass of the moving object and inversely proportional to the force causing the motion.

- All motions are basically intermittent in nature. The series of intermittent micro motions, comprising two different states i.e. move and pause, appear to be continuous due to limitations of our perceptive capacity, like the rapid intermittent projection of photo frames in the cinema hall appearing as continuous motion.

- The attribute of inertia possessed by mass is due to movement and pause characteristics of motion. While pause part opposes movement, the instantaneous movement inside the fundamental length helps the mass to continue in motion.

Motion comprises movement and pause in alternate succession, like that of the second's hand in an electronic watch, but the movement part is instantaneous consuming no time and pause part constitutes time. Motion is the manifestation of NATURE's attribute to be omnipresent within the fundamental unit of length. Force provides the direction to this attribute, which then appears as motion in the direction of the force applied.

**Concept of Space**

Vacuum, the concept of void space was formalized with the physical demonstration of what is known as 'Torricelli's vacuum'. The vast expanses of space beyond our atmospheric limit, like inter as well as intra galactic space, is considered as void. If we look at the scientific analysis, theoretical as well as experimental, carried out since the early days to the present days of modern physics, it will be evident that space has been thought to be a void, filled with either 'ether' (existence of which has been subsequently discarded) or matter and energy as conceived in quantum vacuum. A number of theoretical models regarding the shape of space have been thought of, involving its curvature, limit etc. but the space itself has always been treated as void. Torricelli's vacuum was unwittingly misinterpreted as void space due to the limited knowledge of the atomic world at that time; and the misconception is persisting. In fact, no experiment has ever been carried out to prove that space is void; it is just an assumption. Part of the tubular space, filled with mercury, becomes empty, when the tube is put upside down in the bowl of mercury and the space emptied due to flowing down of mercury is interpreted as void, as nothing is occupying it, notwithstanding the negligible presence of mercury vapour. This interpretation is notional in the context of the present understanding of the atomic structure. Matter, which appears to be a continuum in its own envelope, is not so but composed of inter and intra molecular space, which is almost equal to the space apparently occupied by the matter. A simple computation explains the situation.
The mass and diameter of a proton are:

- Mass of the proton: \(1.672 \times 10^{-27}\) kg = \(1.672 \times 10^{-24}\) gm.
- Diameter of proton: \(10^{-15}\) m = \(10^{-13}\) cm.

Considering that there is no internal space inside the proton, the mass of 1cc of proton = \(\left\{ \frac{\pi}{6} \times (10^{-13})^3 \right\}^{-1} \times \{1.672 \times 10^{-24}\}\) gms. = \(3.2 \times 10^{15}\) gms.

Mass of 1cc of mercury is 13.6gms. Hence, only 0.0000000000004359\% of the space is really occupied and 99.9999999999995741\% of the tube is empty and space only, even when it is filled with mercury. Logically it leads to the conclusion that inside of the tube remains occupied by space, whether it is filled with mercury or not. In that sense the glass part of the tube, rather every object in the universe itself is almost space only. This is highly significant. Following quote from the book 'In Search of Schrodinger's Cat' by John Gribbin\(^4\), aptly depicts the significance (Page 359–360).

"Perhaps the way to a better understanding of the nature of the universe lies in the part of the physical world that has largely been ignored in quantum theory so far. Quantum mechanics tells us a lot about material particles; it tells us scarcely anything at all about empty space. Yet as Eddington remarked more than fifty years ago in 'The Nature of the Physical World', the revolution that created our picture of solid matter as very largely empty space is more fundamental than the revolution brought about by the relativity theory. Even a solid object, like my desk or this book, is actually almost all empty space. The proportion of matter to space is smaller even than the proportions of a grain of sand compared with the Albert Hall. The one thing quantum theory does seem to tell us about this neglected 99.9999999999999... percent of the universe is that it is seething with activity, a maelstrom of virtual particles. ....."

Inadvertent negligence to this very significant aspect of space led to the misinterpretation of the experiment performed by Fizeau. In Ch. 13 of 'Relativity : The Special and General Theory', Einstein\(^5\) wrote:

"..... we then obtain the equation

\[ W = \frac{w}{l} \frac{w}{c^2} \]

which corresponds to the theorem of addition for velocities in one direction according to the theory of relativity. The question now arises as to which of these two theorems is the better in accord with experience. On this point we are enlightened by a most important experiment which the brilliant physicist Fizeau performed more than half a century ago, and which has been repeated since then by some of the best experimental physicists, so that there can be no doubt about its result. The experiment is concerned with the following question. Light travels in a motionless liquid with a particular velocity \(w\). How quickly does it travel in the direction of the arrow in the tube \(T\) (see the accompanying diagram. Fig. 3) when the liquid above mentioned is flowing through the tube with a velocity \(v\)?

![Fig. 3](image)

In accordance with the principle of relativity we shall certainly have to take for granted that the propagation of light always takes place with the same velocity \(w\) with respect to the liquid, whether the latter is in motion with reference to other bodies or not. The velocity of light relative to the liquid and the velocity of the latter relative to the tube are thus known, and we require the velocity of light relative to the tube.

It is clear that we have the problem of Section 6 again before us. The tube plays the part of the railway embankment or of the co-ordinate system \(K\), the liquid plays the part of the carriage or of the co-ordinate system \(K'\), and finally, the light plays the part of the man walking along the carriage, or of the moving point in the present section. If we denote the velocity of the light relative to the tube by \(W\), then this is given by the equation (A) or (B), according as the Galilei transformation or the Lorentz transformation corresponds to the facts. Experiment decides in favour of equation (B) derived from the theory of relativity, and the agreement is, indeed, very exact. According to recent and most excellent measurements by Zeeman, the influence of the velocity of flow \(v\) on the propagation of light is represented by formula (B) to within one per cent. ....."

Einstein drew simile with the man and the carriage with the light and the liquid in the experiment. If this presumption is true then addition of velocities as per classical rule (i.e. \(W = v + w\)) should automatically hold good and there is no reason why it should not. But, the experimental result is in contradiction. Hence, to my mind, the correct interpretation of the experimental result is not that it signifies the validity of the relativistic velocity addition rule, but
that the presumption is not true. Liquid is not playing the role of carriage and is not the carrier of light energy. One important relation between the carrier and the carried, is that they may remain at rest relative to each other. Can this condition be achieved in case of light and liquid, if the liquid is not flowing at the speed of light?

that the flow of liquid is not transmitted to the carrier of light.

This inadvertent negligence has also made the physicists assume that the 'velocity of light in vacuo is constant' irrespective of the velocity of its source, to explain the results of terrestrial observations. In Section 7 of Relativity, Einstein mentioned, "By means of similar considerations based on observations of double stars, the Dutch astronomer De Sitter was also able to show that the velocity of propagation of light cannot depend on the velocity of motion of the body emitting the light. The assumption that this velocity of propagation is dependent on the direction 'in space' is in itself improbable."

It is natural that the velocity of the emitter should get imparted to the photon, which otherwise has the properties of a particle; but observation contradicts what should have naturally happened. Let the event be analyzed.

Photons are emitted by different celestial sources in motion.

Photons travel through space.

Photons reach earth and observed by an observer.

Observer finds same speed for all photons, independent of the speed of the source.

To explain the observation, photons are attributed with the property that their velocity in vacuum is constant and independent of the velocity of the source. But constancy of velocity is not the basic attribute of photons as they travel at different velocities in different situations e.g. in air, water, glass etc. It evidently raises the question which is then opposing the transmission of the velocity of the source to the photons? An alternative explanation of the constancy of velocity of light irrespective of the velocity of the emitter has been developed based on the following premises:

Space is not void but a structured configuration of minute space cells, like the bricks as the constituent parts of a wall.

light displays the transverse wave characteristics.

This is explained below.

Light behaves like particle as well as wave. Propagation of waves requires a medium and light waves depict the properties of transverse wave. In case of transverse wave, medium moves at right angle to the direction of propagation. Let the transverse wave generated at a particular point in space get propagated in all directions. The waves will fill a spherical space of radius 'ct' after a time interval of 't', where 'c' is the speed of propagation of the wave. Let the cross section through the centre of the spherical space at the point of time 't' be considered. It will look like the Fig. 2 shown below.

Looking at the valley and crest of the wave in the clockwise and anticlockwise directions, it will become apparent that the points A, B... of the medium will have to move in both clockwise and anticlockwise directions at the same point of time t as shown in the picture. The XZ plane can be rotated 360° around the ZZ' axis to occupy all possible directions. hence the points A, B ... will have to move both clockwise and anticlockwise in all directions as indicated in the picture at the same point of time t, which is not possible. This situation is different from formation of standing wave. While, the standing wave is the resultant wave of two similar waves approaching each other longitudinally from opposite directions, the waves, in this case, are approaching each other crosswise from opposite directions. The propagation of transverse waves in three dimensions will imply movement of every point of the medium in all directions at the same point of time, except those at the neutral point of the wave. This can only be possible if the point in the space expands like a...
balloon, which will make it appear to move in all directions at the same point of time. After expanding to certain critical size, it will contract to regain the original state. This expansion – contraction process is equivalent to longitudinal transmission at local level, which collectively makes the wave acquire the characteristics of transverse wave in a three dimensional space.

Rotary oscillation of an annular spherical segment of the medium will give rise to the amplitude in the same direction at diametrically opposite ends instead of the opposing one as shown in the Fig. 3.

In this nature of oscillation the amplitude will be maximum at the equatorial plane and will gradually reduce towards the axis of rotation and will be zero at the two ends of the axis. The axis can be rotated 360° in all the three planes to occupy and possible direction, at any point of time, implying that the amplitude can be anything from zero to maximum anywhere and everywhere at any point of time. Otherwise, rotation around ZZ’ axis will again result in opposing phases, as described before, and each and every point will be required to move in all directions simultaneously at the same point of time.

Propagation of transverse wave, like that of the ripples on the surface of water in a pond, is not possible in 3D space. Collection of local longitudinal transmissions collectively acquires the characteristics of transverse wave in 3D space. During propagation of light, the space cells expand and contract like balloon remaining stationary at their respective positions. This makes the speed of light independent of the stationary or moving source.

**Concept of Time**

Two distinctly different views are prevalent regarding the meaning of time. In one, as conceived by Newton, time forms a part of the fundamental structure of the universe and itself is something independent and measurable. Events occur in sequence in the span of time. In other view, as conceived by Leibniz, time is a mental process being a part of the fundamental intellectual structure of mankind comprising number and space i.e. length. Time is not treated as container of events. Sequencing and interval between events are considered as mental process of the observer. However, both the views presume that the arrow of time flows from past to present to future and that time identifies the sequence of events, the duration / intervals between them. Events involve some kind of change in the state, which results as a consequence of some kind of motion, be it at macro or micro level. The present concept of motion i.e. movement and time remaining like Siamese Twins attached to each other at any conceivable stage of the motion, implies that happening of an event i.e. the change of state consumes time. Then time cannot act as an agent to identify the sequence and as the yardstick to measure the duration of happening of events as flow of time must have a rate consuming some time to happen. This becomes a logical fallacy. Peter Lynds also used somewhat similar argument when he mentioned. 'It might also be contended in a more philosophical sense that a general definition of static would entitle a certain physical magnitude as being unchanging for an extended interval of time. But if this is so, how then could time itself be said to be frozen static at a precise instant if to do so also demands it must be unchanging for an extended interval of time? ..... It might also be argued by analogy with the claim by some people that the so-called 'block universe model, i.e. a 4-dimensional model of physical reality incorporating time as well as space, is static or unchanging. This claim however involves the common mistake of failing to recognize that unless there is another time dimension, it simply doesn't make sense to say that the block universe is static, for there is no 'external' time interval over which it remains the same.'

Motion comprises movement and pause in alternate sequence, where movement part is instantaneous and pause constitute time as explained in 2.10 on concept of motion. As movement does not consume time, the concept of position of a point within the fundamental unit of length (let the fundamental unit of length be denoted by the Greek
letter $\zeta$ (zeta) in honour of Zeno) becomes irrelevant. The relative position as well as the distance between two points beyond $\zeta$ will be a discrete function, $d = n \zeta$ where $n$ is a natural positive integer greater than one. The discrete characterization of length is objected on the context that diagonal of a square then becomes a rational multiple of its side. This is notional and may be explained in the following way. Let, three points A, B and C be such that $AB = BC$ and $\angle ABC = \pi/2$ as shown in Fig. 4.

According to the suggested concept no point has unique specified location, rather it can be at any location within $\zeta$. Let, the location of the $\zeta$s where the points A, B and C are located be numbered as $\zeta_{a}$, $\zeta_{b}$, $\zeta_{c}$ and $\zeta_{A}$ = $n \zeta$. Then, $AC = \sqrt{2n} \zeta$, where $\sqrt{2n}$ is irrational and $n$ is an integer. Let, $p$ be a rational number such that $0 < |\sqrt{2n} \zeta - pn \zeta| < \zeta$, then $pn \zeta$ will be the physically equivalent length of the diagonal $AC$. There may be infinite number of values for $p$ within that domain and each value is equally valid.

$\zeta$ is individually non-discrete and pause occurs at the interface of two zetas. Now, an object A moves from P to Q as was shown in Fig. 1 and let us consider following two cases as shown in Fig. 5 & 6:

**First case :**

```
A t t t t t A
P Q1 Q2 Q3 Q4 Q
```

Fig. 5

In the first case $PQ_1 = \xi$ and $PQ = 5\xi$. The number of pauses is 4 and total time to move from P to Q is 4$t$. Now, let the force making the object move and distance from P to Q remain same, but the length of $\zeta$ be such that $PQ = 4\xi$ as shown below.

**Second case :**

```
A t t t t t A
P Q_1 Q_2 Q_3 Q
```

Fig. 6

In the second case the duration of the pause will remain same, but the total time to move from P to Q will be 3$t$.

It becomes evident that the total time to move decreases as the magnitude of $\zeta$ increases. Hence, the duration of an event becomes an inverse function of $\zeta$. As the length of $\zeta$ increases, the discreteness of distance decreases, reducing the number of pause. This reduces the time required to reach the destination. Now, space is discrete if length is discrete. Hence, time is the effect of discreteness of space and is inversely proportional to $\zeta$.

The change in the state may be physical, chemical or positional, involving some kind of motion, be it at the macro or micro level. As movement does not consume time, the change of state does not consume time. It is the pause part of the motion that constitutes the 'present' and we exist, being sandwiched between the 'past' and the 'future'. We can perceive only the present state of the universe, neither before nor beyond. Time is the effect of the ability of human intellect to memorize the present and recover the same recorded in the memory. Hence, we know the past; not the future and time appears to flow from past to future. In fact, time does not flow; it is the static appearance of the Nature. Time is the pause part of the motion i.e. the pause state of the NATURE and is the function of discreteness of space.

**Conclusion**

The concept of position and time loses its validity in the domain of the $\zeta$ as defined in the proposed concept of motion. Hence, in the domain of the $\zeta$ there is no causation to make motion, no time, no result. The concept of position and time comes into play when we are observing events outside $\zeta$. The concept of occupation of space by matter is notional in the context of present knowledge of the structure of atom. The space inside the tube, which was assumed to be filled with mercury in the experiment carried out by Torricelli, was in fact 99.9999999995741% space only. In that sense, space is neither filled nor empty and it is inside as well as outside everything that we sense. The eastern philosophy about space and time is similar to this proposed concept. Following citations from the Indian and Chinese philosophy are relevant. Part of the translation in English is quoted from 'The Tao of Physics' written by Fritjof Capra.

'The Upanishad' says about 'Brahma', which is conceived in Indian philosophy as the source of all creation'.

'It moves. It moves not. It is far. Also it is near. It is within everything. Also it is outside everything.'

(5 Isopanishad)

In the words of the Zen master Dogen. 'It is believed by most that time passes; in actual fact, it stays where it is. This idea of passing may be called time, but it is an
incorrect idea, for since one sees it only as pasing, one cannot understand that it stays just where it is.’

Swami Vivekananda, the great disciple of Shree Shree Ramakrishna Paramahamsadev, in explaining the Indian philosophy about 'Brahma (the source of creation) and Jagat (the physical world)' wrote : 'Time, space and causation are like the glass through which the Absolute is seen. .... In the Absolute there is neither time, space, nor causation.'

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References