# The Deep Mystery of the Universe Behind Zeno's Paradox

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**Abstract**

Zeno's paradoxes of motion are four related paradoxes created by an ancient Greek philosopher in 500 B.C. In one of the well-known paradoxes, Achilles, who is a fast runner, chases a tortoise who is initially at a point P ahead of him and moving slowly forward. Zeno argued that, by the time Achilles arrives at point P, the tortoise will have moved forward to another point $P_1$. Although Achilles is now closer to the tortoise, he will not catch up on the second try again because by the time Achilles arrives at point $P_1$, the tortoise will have moved to another point $P_2$ and so on. Therefore, Achilles will never catch up with and overtake the tortoise. But we know that a fast runner overtakes a slow runner in reality. This paradox has puzzled philosophers, mathematicians and scientists for millennia. This paper reveals the mystery of the universe behind Zeno's paradoxes. There is no entity called an electron or a proton moving from one point to another point in space as we know it. It is profound that philosophers were able to probe the deep mystery of the universe by logic alone 2500 years ago!

## Introduction

Zeno's paradoxes of motion are four related paradoxes created by an ancient Greek philosopher and logician in 500 B.C. The four paradoxes are known as the Achilles and the Tortoise paradox, the Dichotomy paradox, the Arrow paradox and the Stadium paradox. Zeno's paradoxes survived in Aristotle's writings, in which he attempted to refute Zeno's arguments.

Below I give brief descriptions of each paradox before proposing the solution.

<u>The Achilles and the Tortoise paradox</u>

In this paradox, Achilles, who is a fast runner, chases a tortoise who is initially at a point P ahead of him and moving slowly forward. Zeno argued that, by the time Achilles arrives at point P, the tortoise will have moved forward to another point $P_1$. Although Achilles is now closer to the tortoise, he will not catch up on the second try again because by the time Achilles arrives at point $P_1$, the tortoise will have moved to another point $P_2$ and so on. Therefore, Achilles will never catch up with and overtake the tortoise. But we know that a fast runner overtakes a slow runner in reality.


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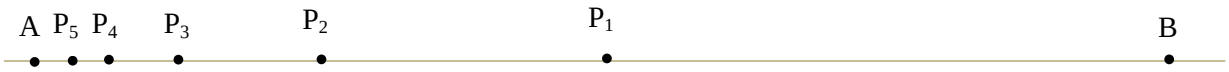
The Dichotomy paradox

In this paradox, for any object to move a distance *D* from one point A to another point B, first it has to move a distance *D/2* to the mid-point between A and B, say point $P_1$. Likewise, to move from point A to point C, first it has to move a distance D/4 from point A to the mid-point of points A and C, say point $P_2$, and so on. This implies that the object has to make infinite steps to traverse the distance between A and B and this leads to the conclusion that the object cannot move from point A. But we know that objects can move between two points in reality. From this, Zeno concluded that all motion is illusion.

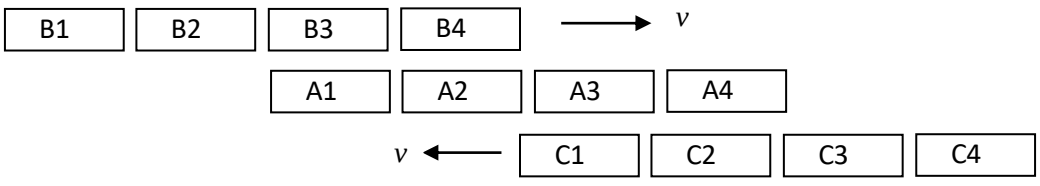



The Arrow paradox

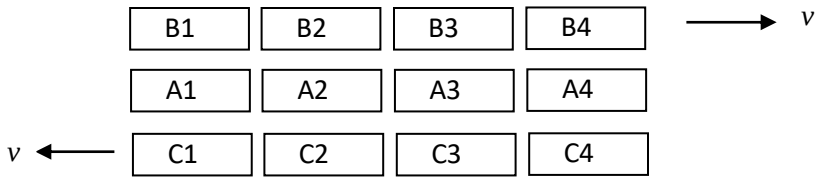
This paradox is about an arrow in flight. At any instant of time, the arrow is at rest because the arrow cannot make any movement in an instant of time, within zero time interval. And if the arrow is at rest at a given instant of time, then there is no way to tell the difference between a moving arrow and an arrow at rest, so a moving arrow cannot move, which is a contradiction[1].

The Stadium paradox

The stadium paradox is described as follows. We start with three rows of four blocks each at an instant of time as shown below. The 'B' blocks move with velocity *v* to the right and the 'C' blocks move with an equal velocity *v* to the left. The 'A' blocks are stationary.




Finally the blocks will look as follows.




Consider the block B4. It passes two A blocks , but four C blocks during the same time interval. The Stadium paradox concerns these two times. According to Zeno, if the former takes time interval $t$ , the latter takes time interval 2t . This would be a paradox because B4 passes two A blocks , during the same time interval that it passes four C blocks. Therefore, this would lead to the paradox $t = 2t$ .

It is known today that the Stadium paradox of Zeno as presented above is fallacious. It is incorrect because the time it takes B4 to pass two A blocks is equal to 2/v and the time it takes B4 to pass four C blocks is 4/2v . Therefore,

$$t = \frac{2\ blocks}{v\frac{blocks}{unit\ time}} \quad \text{and} \quad t = \frac{4\ blocks}{2v\frac{blocks}{unit\ time}} \quad \Longrightarrow \quad t = t$$

, so there is no paradox.

Then why is the Stadium paradox called a paradox? It has been speculated that perhaps the above description of the Stadium paradox was a misrepresentation of Zeno's Stadium argument by Aristotle. Therefore, alternative interpretations have been proposed about Zeno's possible argument.

One such interpretation is a follows. Assuming discrete space and time, consider the blocks B4 and C1. At one moment of time, C1 is to the right of B4 and at the next moment C1 is to the left of B4. We notice that there is no moment when these two blocks are aligned. It has been argued that the stadium paradox was devised to refute the idea of discrete space and time. However, I have yet to appreciate this argument.

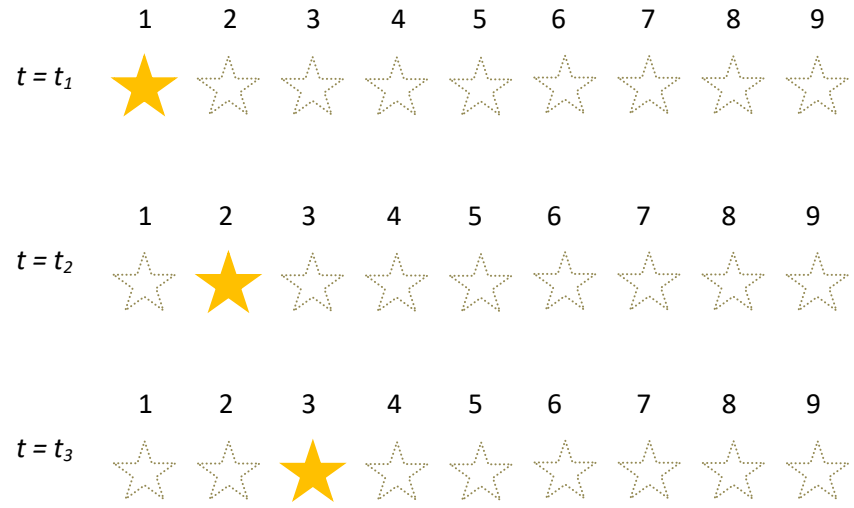
These four Zeno paradoxes of motion have baffled philosophers, mathematicians and scientists for millennia. They have not been really solved to this date because proposed solutions solved only some of the paradoxes leaving the others unsolved and because there is no consensus on a solution so far.

In this paper, I propose a new solution which can solve all the four paradoxes.

**The deep mystery of the universe behind Zeno's paradoxes**

Consider a row of lamps as shown below.

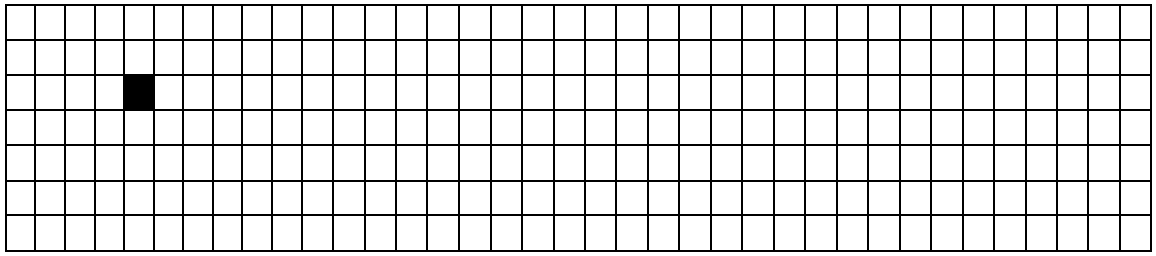

At first all the lamps are switched off, at time $t = t_0$ , as shown above. Then at time $t = t_1$ lamp 1 is switched on, as shown below. Then at time $t = t_2$ lamp 1 is switched off and lamp 2 is switched on. Then at time $t = t_3$ lamp 2 is switched off and lamp 3 is switched on, and so on.



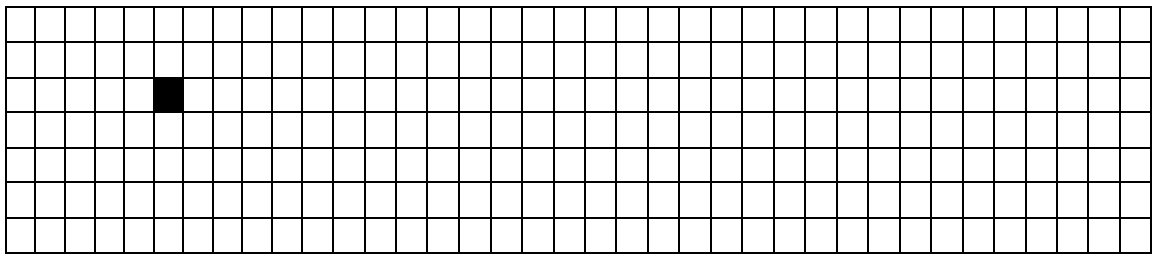

To an observer watching the row of lamps from a distance, it appears as if a single lamp is moving smoothly from left to right. However, we know that this is only an illusion because there is no lamp moving from left to right.

As another example, consider a black dot moving across a computer screen from left to right, as shown below. Each cell represents a pixel or a group of pixels of a computer screen. The positions of the black dot at $t_0$ , $t_1$ and $t_2$ are as shown below.

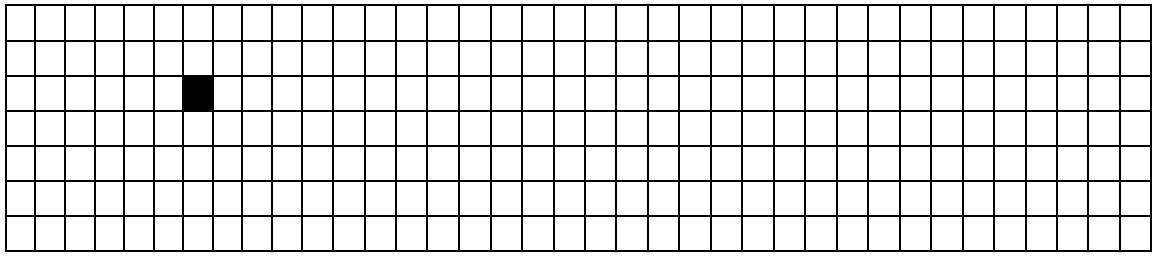
$t = t_0$



$t = t_1$



$t = t_2$



Again, for an observer looking at the computer screen from a distance, it looks as if *a black dot* is moving from left to right. This is only an illusion because there is no 'a black dot' moving from left to right. What actually happens behind the illusion is that each pixel is turned on and off at the right time to give the illusion of 'a moving dot'.

I propose one of the deepest mysteries of the universe as follows. The motion of a physical object and the physical object itself is basically the same or similar as the moving lamp and the moving dot discussed above. Just like there is no lamp moving from left to right and just like there is no black dot moving from left to right on the computer screen, there is no physical object moving from one point to another point in space as we know it. The motion of physical objects is only an illusion, as Zeno concluded. This paper makes the conclusion that not only motion, but also physical objects themselves are an illusion. Motion of a physical object ( rather the illusion of motion) occurs as 'pixels' in space 'turn on' and 'turn off' at the right times to give the illusion of motion. Therefore, there is no physical object moving from here to there as we know it.

*When a particle moves in space, what happens in reality is that the particle appears at a point in space at one instant of time, and then, at the next instant of time, that particle disappears from that point and an identical particle appears at the adjacent point in space, creating the illusion that the same particle is moving in space*. There is no 'the same' particle moving in space, just like there is no 'the same black dot' moving across the computer screen.

Therefore, it will not be surprising if we say , just as the black dot on a computer screen can be deleted at will by the human programmer/ user, a physical object can also be 'deleted' from the universe by the 'programmer' of the universe.

Therefore, the universe and the laws and phenomena of the universe, and all the objects in the universe are just illusions at a grand scale.

The correctness of this theory is evident by the fact that it resolves all of Zeno's motion paradoxes with ease.

The Arrow paradox is automatically solved because at any instant of time, and at every instant of time, the arrow is at rest. There is no motion of the arrow as we know it, and it is only an illusion. Just as the moving dot on the computer screen is at rest at any instant of time, so is a moving object. The answer to the puzzle "then how can there be motion? " is that there is no motion as we know it. There is only an illusion of motion.

The Achilles and tortoise paradox is also solved because Achilles cannot get closer to the tortoise than the distance between two adjacent 'pixels' in space, and therefore he will catch up with and overtake the tortoise eventually.

The Dichotomy paradox is also solved because a particle moving from one point in space to another point takes only finite number of changes in position, just like the moving dot makes only finite number of steps to move from the left side of the computer screen to the right side.

The Stadium paradox is that there is no moment in time when B4 and C1 are adjacent. This will not be a paradox because no two blocks will be adjacent in reality because there are no moving blocks as we know it, there is only an illusion of motion.

## Conclusion

In this paper, all four of Zeno's paradoxes have been solved. There are no physical objects moving from one point to another point in space, just like there is actually no black dot moving across a computer screen, that is , the motion of the black dot across the computer screen is only an illusion. The view of an electron moving in space is deeply flawed as we know it because *there is no entity called electron moving in space as we know it*. The deep reality is that an electron appears at a point in space at one instant of time. Then at the next (discrete) instant of time, that electron disappears from that point and an identical electron appears at the next adjacent point in space, creating the illusion of an entity called an electron moving in space as we know it. This view can resolve all four of Zeno's paradoxes.

Glory be to God and His Mother, Our Lady Saint Virgin Mary

## Notes and references

1. I was acquainted with Zeno's paradox only relatively recently, not more than two or three years ago. However, long before I knew about Zeno and his paradox, I remember motion paradoxes similar to the Dichotomy paradox and the Arrow paradox come to my mind at different times in the past, perhaps since thirty years ago?, and being baffled before abandoning them for the time being.

## Bibliography

1. *Why Zeno's Paradoxes of Motion are Actually About Immobility*, by Maël Bathfield

2. *Zeno's Paradoxes* , by W. C. Salmon

3. *This Is How Physics, Not Math, Finally Resolves Zeno's Famous Paradox*, by Ethan Siege, Forbes

4. *Aristotle, Zeno and the Stadium Paradox,* by Kevin Davey