# Zeno: The Einstein of Greece?

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## Introduction

Ten paradoxes of Zeno survive, wherein he attacks plurality to defend his master Parmenides' monism. The two most famous paradoxes have puzzled philosophers for ages and are still a topic of debate today: the arrow paradox and the dichotomy paradox. Zeno was however criticized for contradiction, using both a discrete and continuous perspective of time (McTaggart, 1908).

In this paper I defend Zeno. First, I elucidate these two paradoxes. Then, I explain why they seem to contradict each other, and I propose a new understanding of those perspectives of time to solve the contradiction. Finally, I contrast my proposition with the role of time in Einstein's Special Theory Of Relativity (STOR). Crucial to the plausibility of my proposition is accepting the following principle: Any extrapolation of a theory is a part of that theory.

The arrow paradox assumes time to consist of points (finitely divisible/discrete). Movement is impossible because anything at a point in time cannot move to where it is, for it is already there; nor can it move to where it is not, for it is not there (Aristotle I). To illustrate the principle of this paradox, imagine a flipbook of an arrow. To make the arrow move, we have to flip a row of pictures. This motion would only be an illusion, because each picture must 'contain' a different arrow: An arrow cannot move from one picture to another.

The dichotomy paradox assumes time to consist of stretches (infinitely divisible/continuous). Movement is impossible because anything moving towards a point in space has to cross an infinite number of distances in a finite amount of time (Aristotle II). To illustrate the principle of this paradox, imagine a row of numbers. Try counting from 0 to 10, but with a small catch: you must include ALL numbers between 0 and 10. It is impossible to count to even the first number, because it can always be divided further: No matter how many 0's you add between 0,000… and …0001, you can always add more.

If Zeno thus treats time as infinitely divisible/continuous, a contradiction arises in the arrow paradox: 'Pictures' of the arrow become impossible, because there must always be some passage of time in that picture left to divide. Conversely, if Zeno treats time as finitely divisible/discrete, the dichotomy paradox falls apart: As you count all numbers from 0 to 10 with the smallest number counted being two decimal places, it becomes possible to count to 10. Zeno, however, utilizes both of these perspectives. Even obeying the principle of charitability, how could we possibly salvage anything from his theory?

The paradoxes must be seen in light of the monism that they defend. Most interesting, then, is the arrow paradox. The way Zeno frames it, the only explanation for the phenomenon of movement between two points in time would be that those points are occupied by different objects. But not only would that be impossible, it also seemingly moves us *away* from monism… or does it?

## The Proposition

Not necessarily. I propose a different understanding of time, with which Zeno could have solved the contradiction. While we measure time the same way we measure speed or weight, Zeno could have viewed time as an inherent part of a shape, to be measured like height or width. To illustrate this, consider a fish: It can change its speed and weight; however, in doing so, the 'object' that is the fish remains unchanged. The attributes speed and weight are separate from the 'object', unlike height and width. If the fish was chopped in half - in other words, its height divided in two - it turns into two parts of (ex-)fish, and doing so *would* change the object. The view I propose to replace considers time to be a separate attribute like speed and weight: When the fish grows older, one would not suddenly think it turned into a different fish. My proposition, although subtle, is this: Zeno *did* consider time to be an inherent attribute, or dimension, like height and width.

To illustrate this, we return to a simplification of the arrow paradox. Viewing time as an inherent dimension of the arrow, Zeno believes that, when the arrow is fired, a 'string' of distinctly separate arrows make up the movement from the bow to the target. When we observe the arrow flying, only a single "time-slice" is presented to us in a given moment. Even though this time-slice lacks the dimension of time, and can therefore not exist in our world, it still plays an important role in understanding Zeno's view. The movement as a whole can be thought of as the 'true' shape of the arrow, which I call the "super-shape". A time-slice is to a super-shape what a square is to a cube. A way to understand this paradox is to imagine the arrow in a given moment as a ripple (time-slice) moving over a body of water (its super-shape, spanning from the bow to the target), which *would* be in accordance with monism.

The principle of the dichotomy paradox fits onto all of this like a glove. Whereas before, the premise of infinite divisibility contradicted the arrow paradox, in our adjusted view it serves to further clarify. Recall the counting example: While it is possible to *comprehend* the numbers between 0 and 10, it was impossible to count, because one could always further divide a number. In what follows, these pairs are compared: the 'comprehended numbers' to the aforementioned 'time-slice'; 'counting' to the 'ripple-like passage of time'; and a 'stretch of numbers' to the 'super-shape'. Then we can see why these paradoxes no longer clash, but actually drive the same point.

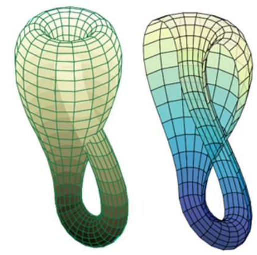
Take the comprehended number 3. We might use it to measure 3L of water. We would be wrong: In reality, we use the stretch of numbers leading up to 3 to express liters of water, because the point that is the number 3 on a scale (the point that comes after 2,999… …99) is infinitely small, and therefore incapable of measuring anything. To prove this, if we take a stretch of numbers away, say, from 0,5L to 1,5L, there would be less water measured, even though we are not dividing the point that is the number 3. Likewise, while a super-shape consists of an infinite number of time-slices, time-slices are not what is measured when we measure time in the dichotomy paradox, and so the contradiction is resolved.

Furthermore, this example explains what is happening in the arrow paradox: When we count to 3L (discretely, this time), the liters we count past do not disappear (where would they go?), and neither do the liters we have yet to count (the water is still in front of us). When we count, it is not the numbers that move *from* 0 to 3; rather, it is our perception that moves *over* the stretch as whole, like a ripple. The numbers do not cease to exist when we divert our attention from them. Likewise, the arrow does not move *from* moment to moment; rather, it is our perception that moves over its super-shape.

To summarize my proposition, I think Zeno envisioned time as the $4^{th}$ dimension; static, and inherent to form. The arrow paradox serves to prove that time is made up of moments the way a cube is made up of squares. The dichotomy paradox serves to prove that these squares do not move *through* the cube; instead, the squares statically *form* the cube.

## From Zeno to Einstein

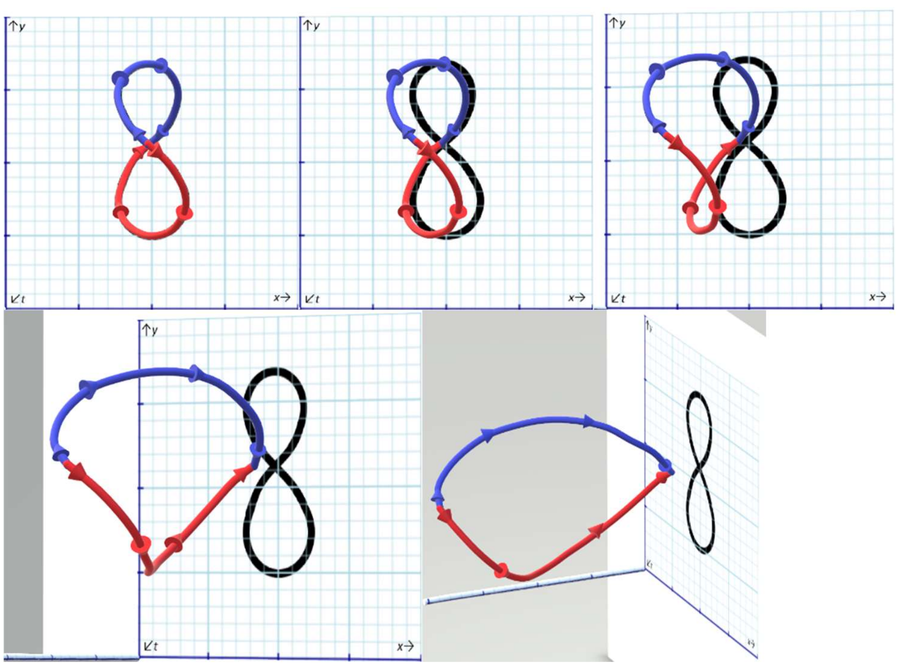
My proposition of Zeno's view shares the concept of time as the 4th dimension with the B-theory of time and its alignment with the STOR (Andraus, 2016). Unlike these theories, however, my proposition allows time to ripple (move) back and forth. I illustrate this contrast between my proposition and the STOR with the respective theories' approaches to the Klein bottle, a 4th dimensional shape. As a 3rd dimensional shape, the Klein bottle intersects itself (left image); as a 4th dimensional shape, it does not (undepictable). This is possible in both theories when a circle moves through the *xyz* coordinates of intersection at different *t*'s (time).



(Tttrung) (Nicoguaro)

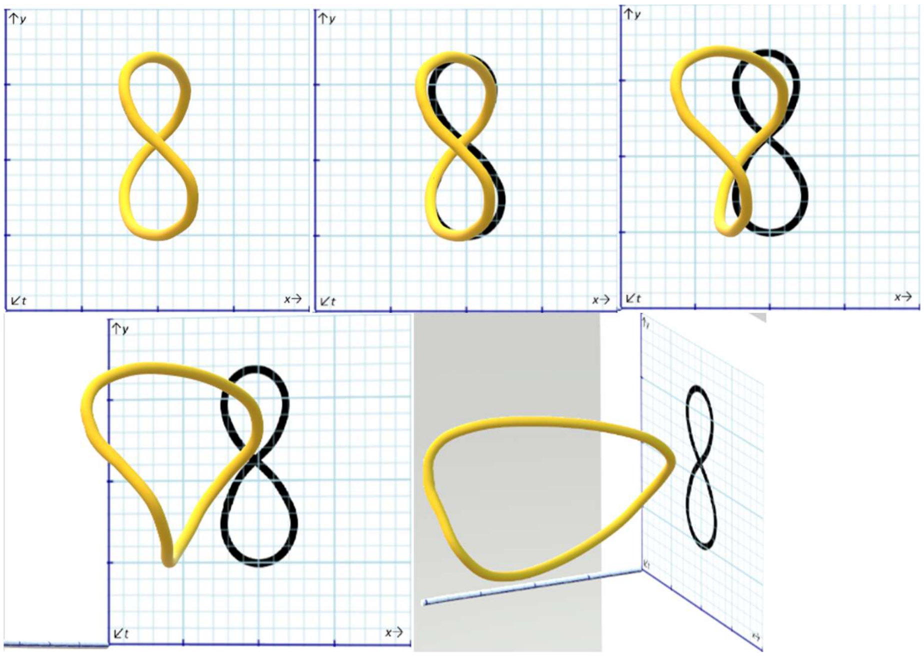
The images below demonstrate this principle in 3D space by drawing the path that the circle(s) takes. The path in 3D is the world-line/super-shape in 4D. As a frame of reference, I project the shadow of that path, to be thought of as a dissected Klein bottle (right image).

The approach from the STOR (shown below) is limited to an irreversible, non-Euclidean, passage of time from *t*0 to *t*1, as illustrated by the arrows. Therefore, two paths, and so, two objects, constitute the bottle in time evolution[1], as illustrated in red and blue.



[1] https://upload.wikimedia.org/wikipedia/commons/2/24/Klein_bottle_time_evolution_in_xyzt-space.gif

Because my proposition treats time as inherent to objects, it can span freely between *t*0 and *t*1. Resulting is a *single* path, and so, a *single* object in Euclidean space. The images below reflect this with only one colour and without arrows: instead of passing, time *is*.




## Conclusion

I attempt to resolve the contradiction of Zeno's paradoxes by adjusting our concept of time. My proposition is an extension of Parmenides' monistic model, viewing time as an inherent dimension to existence. I explained the emergent impossibility of motion and how this extended model compares to the B-theory/STOR. Zeno's view seems consistent with Einstein's model, but a closer look reveals a clear difference: spatiality.

Aristotle raises criticisms regarding both the concept of infinity and the premise that everything is either in motion or at rest, respectively crucial to Zeno's paradoxes. However, Aristotle's attacks do not relate to the contradiction I aim to resolve within the framework of this paper.

## Bibliography


Aristotle. *Physics* 6.9 I: 239b11–13=29A25;-8.8-263a5–6 [not in DK]

II: 239b5–7=29A27;-6.9-239b30–33 = 29A27

McTaggart, J.E. 1908. *The Unreality of Time*. Mind, XVII(4):457-474.

Andraus, A. 2016. Zeno-machines and the metaphysics of time. *Unisinos Journal of Philosophy*, XVII(2): 161-167

www.iep.utm.edu/zenos-paradoxes/#H4