What you would see if something goes backwards in time

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July 2018, manuscript

Introduction

There are at least three mutually incompatible explanations of reverse time, and these explanations are often mixed together. It is important to clarify which interpretation we are talking about. It is also essential to at least outline which logical-philosophical assumptions, and which tacit metaphysical suppositions contradict reverse time – if they really are contradictory. Since most of the laws of physics do not necessarily specify the direction of time, the laws of physics do not in themselves exclude reverse time. Using a space-time graph it is also possible to depict an object moving backwards in time. According to Feynman:

> Even more strange is the possibility that the electron emits a photon, then travels backwards in time to absorb a photon, and then proceeds forwards in time again. ... This phenomenon is general. Every particle in the Nature has an amplitude to move backwards in time, and therefore has an anti-particle. [1]

If, however, reverse time can be represented on a space-time graph, then the logical formulas describing that graph have a model, and consequently the concept of reverse time cannot be contradictory. However, the best explanation is a working model in cyberspace to illustrate our experience and what we would see if a physical object were to proceed in reverse time. This is the topic of the present paper.

[1] Feynman, R. P. 1985, *QED The Strange Theory of Light and Matter*, 97-98: Princeton University Press. I am following Feynman's thoughts on reverse time.

Explanations of reverse time

(1) Changing the past. Suppose I meet a time traveller somewhere in the future. We have a brief conversation during which she tells me about the purpose of her trip and her further plans. However, there is one thing that she cannot do, even if she plans to: she cannot go back to my past in order to meet me somewhere. I know that I did not meet her earlier, and if it did happen, she would change the past and change the truth value of many propositions, which, based on classical logic, is impossible. The truth values of the propositions are outside time, eternal, unvarying. In another example, I fail to look round at a junction and crash my car. But never mind, I go back in time and eliminate the accident, and this time I'm careful to look around. This is impossible: not even God can change the past, as Aquinas rightly said. It is important to understand the problem properly. You cannot go back in time at a later stage, or you would violate the rules of classical logic. This is because there is a logically complete, consistent description of all the states of the world, something like Wittgenstein outlined in his Tractatus, in his own mystical language, and returning to the past would always contradict this complete description. That I visited the Louvre in February 2006 is a fact. But the opposite, that I did not visit the Louvre in February 2006, would also be a fact. Likewise, it is also a fact that I did not meet a time traveller in the Louvre, thus a time traveller could not go backwards in time and meet me in the Louvre, because she cannot change the past.[2]

(2) Some kind of metaphysical interpretation. You can go back in time, but in another possible world; you can go back in time, but in a different time dimension, or you can apply a distinction between external and internal time, or similar approaches. This may be argued without logical inconsistency, although it raises a number of new questions. The main problem is that it is a deceptive sidestep away from the real problem, since in this case there is no real reversal in time. We go backwards in time, but not in original time, rather in something very similar.

(3) An approach represented by space-time graphs. In this understanding of reverse time we do not go backwards in time later, nor do we change

[2]Many philosophers support and apply the so-called wormhole theory, which I do not discuss here.

the past. There is neither another possible world nor a different time dimension. Let me explain.

My friend sometimes goes backwards in time. He is going to the fridge to bring me a beer. The fridge is ten steps away from us. As he takes the fifth, sixth and seventh steps, he is going backwards in time. During the backwards time period, my friend has triplicated. His first instance goes ahead, the second instance goes backwards, and the third instance again goes ahead. The first and second instances merge at the fifth step and then disappear, while only the third instance goes ahead. The rest of the time he proceeds in the normal way, going singly forward in time. Using the model, we will see that, in this concept, at some moments there are three things at the same time in different places doing the same thing. It may be strange, but it is not apparently illogical.

What is counter to logic?

As I sit here in my chair, I know that I sat here yesterday and that I existed continuously between the two times. I did not disappear even for a moment. This is brute fact, and not necessarily the truth. Classical (extensional) logic tells us almost nothing about the world. Logic does not decide what exists and what does not. It says nothing about the nature of time. It cannot be ruled out that one thing can be in multiple locations at the same time, or at certain times can disappear for a while, because logic does not know the nature of the world. Beyond the laws of identity, there are only one syntactic and two semantic presuppositions in elementary (first-order) logic regarding the world:

(4) There are no objects with inconsistent properties. In other words, the formula '$\exists x(\sim Fx\&Fx)$' is refutable. (This is a consequence of Aristotle's principle of non-contradiction)

(5) There is something – that is, the domain of the universe is not empty. (This is a semantic presupposition originating from Tarski.)

(6) Propositions have one, and only one, true or false truth value, and truth value is unalterable in time. (Frege)

The last presupposition (6) is in fact a meta-axiom that many philosophers do not understand or question, as it leads to logical determinism in a certain sense. (In fact it does not, but that is beyond the scope of the present

discussion.) This, in itself, excludes the backwards passing of time according to interpretation (1).

It is easy to misunderstand axiom (6). Classical logic denies that something can be at once an apple and not an apple, that something can be white and not white at the same time. However, classical logic does not know if there are any apples and pears at the same time, or both black and white at the same time. These common sense rules are even more important than the rules of logic, but we know them from elsewhere and use such principles without hesitation. For example, if x is a certain kind of fruit, then it cannot be different types of fruit or an animal. We know that if any x is white, then x is not black, and we know a number of similar, trivial things. But these are not logical truths: we know them from elsewhere. They originate from ordinary language and not from the language of formal logic.

Logic has almost nothing to say about the nature of physical objects. The principle of identity does not rule out that a person can exist in such a way that there are two instances of them in two different places. In this case, neither one of the instances is that person, but rather the two instances together. One instance is part of, say, the person-in-forward-time, and the other instance is part of the person-in-reverse-time. This would be very strange, and would be proscribed not by the laws of logic, but by biological laws. But this goes beyond logical-philosophical questions.[3]

A common sense metaphysics

We hold the following metaphysical beliefs in the case of medium, human-sized, visible physical objects:

(7) The existence of physical objects is objective. The path – the space-time curvature relative to a coordinate system – and all the internal properties of a physical object exist and are clearly defined even when it is not measured or not perceived. (This supposition is not valid in the case of certain objects in microphysics, according to most physicists.)

(8) The physical object's existence in time is consecutive. The physical object preserves its self-identity – that is, will remain the same throughout itself – at different space-time points along its path. It does not cease and is not constantly reborn as it moves in time.

[3]This was earlier clarified by Lewis, D. 1976, The paradoxes of time travel.*American Philosophical Quarterly*, 13 (2):145-152.

(9) The existence of a physical object is continuous, not a series of discrete states.

(10) A physical object will remain numerically identical throughout itself, it will not multiply, and it will not appear simultaneously in multiple places at the same time. Conversely, two objects are never merged into one object that is identifiable with them.(Weak Lockean Principle)[4]

(11) The possible changes gradually become smaller as we measure the properties at shorter time intervals. The changes in a physical object's properties can be described by differentiating functions. (The 'Natura non facit saltus' principle appears in the writings of Leibniz. This is not valid in modern microphysics.)

(12) The world is such that all physical objects can be clearly identified. They are unmistakable with other things on the basis of their continuous path and minor changes. (A corollary of Leibniz's principle of the identity of indiscernibles.)

It is not at all obvious that the above assumptions are valid for all material objects. Certainly, all six assumptions are not valid for all existing physical objects. Assumption (8) is certainly not valid for decomposable household objects. Assuming the continuity of properties – that is, describing their values with real numbers – would be a simplistic assumption. In fact, measurement results are always rational numbers. The use of real numbers in physics is an idealisation; it is a useful assumption that the toolkit of mathematical analysis can be used. On the other hand, I will demonstrate that assumption (10) is incompatible with the backwards time travel of physical objects.

What would we see?

In his *Philosophical Investigations*, Wittgenstein said: 'Don't think, look!' I have therefore used a simplified model and figures to obtain a better understanding. I assume that time and space are discrete and not continuous. An object moves forward along a line to a point from which it returns to the starting point. Meanwhile, the object is going backwards in time for a short

[4]'There cannot be two or more indiscernible things with all the same parts in precisely the same place at the same time. ... I call this the Weak Lockean Principle since it resembles a principle suggested by Locke, but this is considerably weaker and more compelling than Locke's principle.' Jeshion, R. 2006, The Identity of Indiscernibles and the Co-Location Problem. *Pacific Philosophical Quarterly*, 87 (2):163-176.

period. The next spreadsheet model is a working model. It uses cyberspace and works in real time, and it simulates reverse time. The spreadsheet model can be downloaded at:

`http://ferenc.andrasek.hu/models/rev-time2.xlsx`

The finite, one-dimensional world of the model features 15 locations, and its finite time consists of 15 moments. A physical object moving in this world along the track reaches the second location at the second moment. It proceeds to the 10^{th} location, from where it returns to its starting point. It goes backwards in time between the fifth and the seventh locations, in the interval between the fifth and the third moment. (Figure 1)

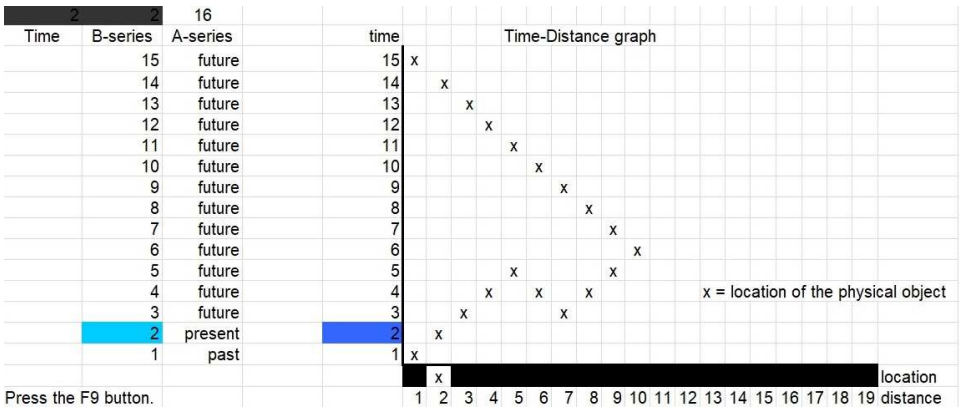

Figure 1:

The object continues consecutively. In the next, third, moment, it arrives in the third place, but it then multiplies and also appears in the seventh location. Thus, at the third moment, it has two locations at the same time. This contradicts assumption (10) above. It then proceeds. From here, the second object instance fissions and the first part moves back and the second part moves forward. Thus, at the fourth moment, it is in three locations at the same time: the fourth, sixth and eighth location. Once again, this contradicts assumption (10) above. (Figure 2) At the fifth moment, the first two instances have merged at the fifth location, and the third instance has arrived in the ninth location. We now have two object instances again. Again, this is in conflict with assumption (10) above. At the sixth moment, the physical object arrives at its destination, turns round, and goes back. There is then only one instance of it. From now on it proceeds in normal

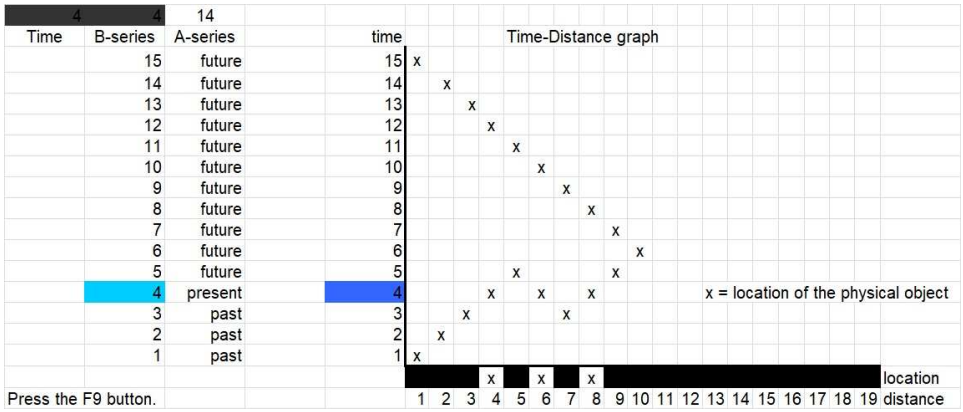

Figure 2:

time. At the 15^{th} moment, the object has returned to the starting point. In the fifteenth moment the object has returned to the starting point.

Summary

If reverse time is interpreted on the basis of a space-time graph, in addition to the laws of logic, and if we adhere to the above Weak Lockean Principle, common sense assumption (10), it is impossible to move a physical object backwards in time because the physical object would be multiplied at one moment in multiple locations. If we do not adhere to the Weak Lockean Principle and stipulate that only single reverse motion is possible, then it is possible to travel in reverse time. However, this raises a difficult question. What is the object's speed and acceleration at the precise moment of turning back in time?