Is time real? Is time travel possible?

Today we have two questions to discuss: is time real? And is time travel possible?

The answers to both of these questions, as we'll see, are intertwined with our best current theory of space and time: Einstein's theory of relativity.

Let's start with the first question. When we ask whether time is real, we are asking whether certain temporal properties — properties having to do with time and its passage — are real.

It will be useful to begin by introducing a distinction between two different kinds of temporal properties: A properties and B properties.

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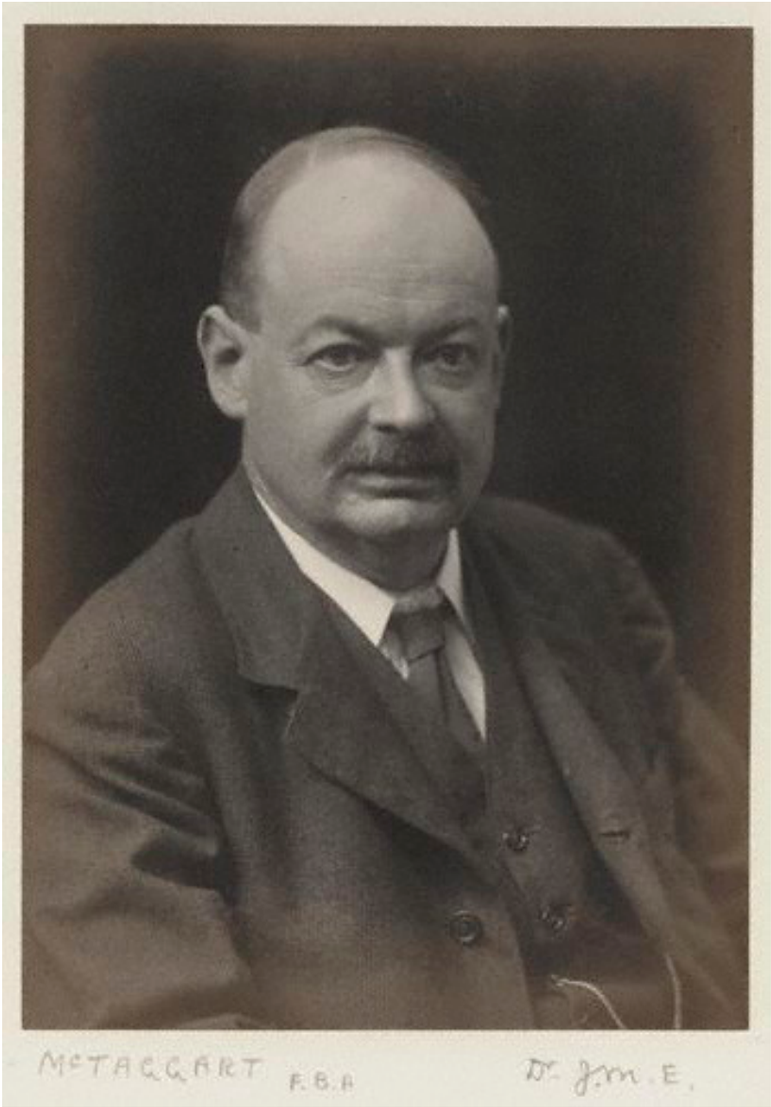
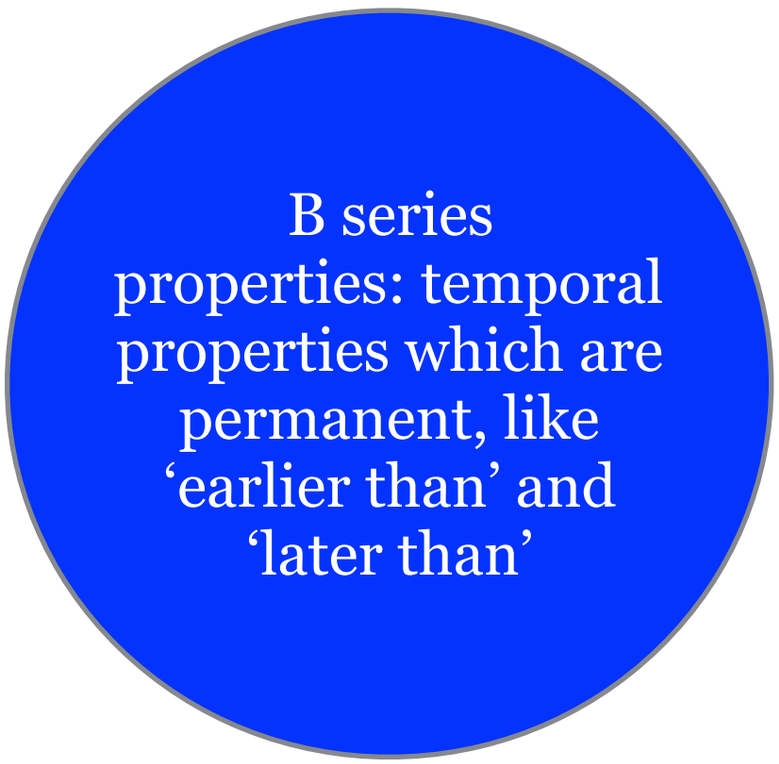
These very un-memorable names are due to the Cambridge philosopher John McTaggart Ellis McTaggart. Personally, McTaggart's life seems to have been unexceptional, though marked by eccentricity. He was known around Cambridge for his habits of getting around by riding a tricycle, and for saluting cats when he passed them.



The B properties include “earlier than” and “later than” and are permanent, in the sense that if an event has a certain B-series property, it always does. So, for example, if X is earlier than Y, then X is always earlier than Y.

The A properties include “past”, “present”, and “future.” These properties are not permanent: so, for example, if an event is future, this does not imply that it will always be future.

It’s important to get a handle on this distinction; let’s run through some examples.



A series properties: temporal properties which are not permanent, like ‘past,’ ‘present,’ and ‘future’

B series properties: temporal properties which are permanent, like ‘earlier than’ and ‘later than’

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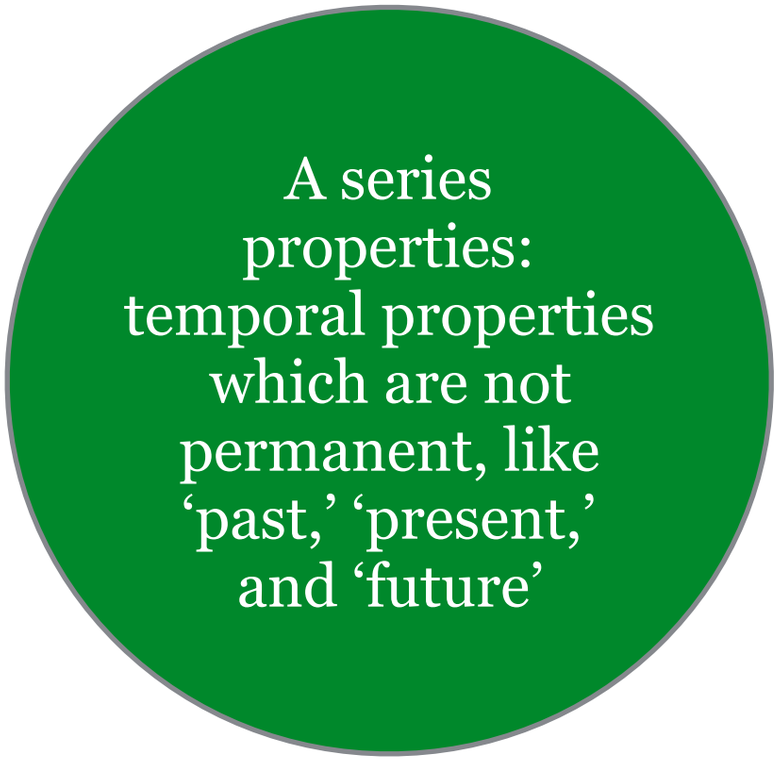

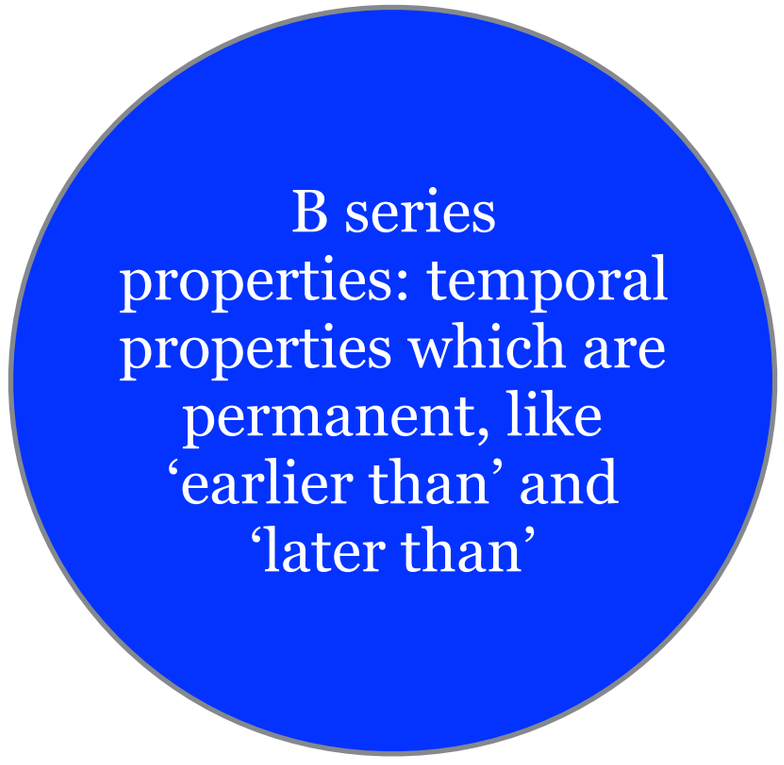

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I think that two things are clear: there is a genuine distinction between these two classes of properties, and in our ordinary thought about time, we do think that some events really have both kinds of properties.

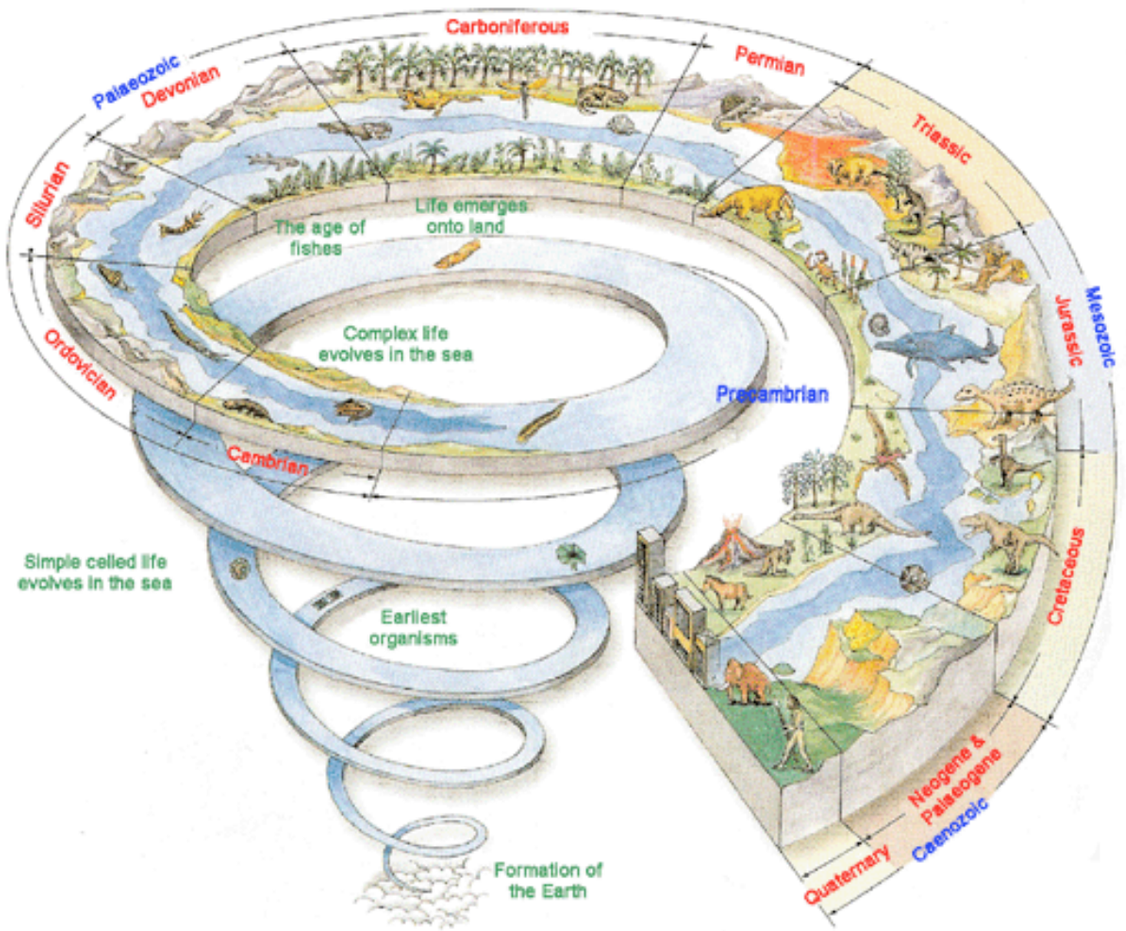
A series properties: temporal properties which are not permanent, like ‘past,’ ‘present,’ and ‘future’

B series properties: temporal properties which are permanent, like ‘earlier than’ and ‘later than’

When we ask about the reality of the past, the present, and the future, we are asking about the reality of the A-properties: we are asking whether there is a real, objective difference between being past, being present, and being future.

In our ordinary thought, we seem to assume the reality of the A-properties. There are three ways to bring this out.

The first is that, if there are no A properties, this seems to imply eternalism: the view that the past and the future - and the objects and events of the past and future — exist in just the same way as the objects and events of the present moment. This seems to be a consequence of the denial of A properties, since there is no property of "being the present moment" which singles out one time as special. But eternalism strikes many people as a very counter-intuitive claim.



The second comes from a kind of thought experiment. Suppose that you have complete amnesia, and are presented with a series of books which detail the whole history of planet earth -- past, present, and future. You might think that when you finish reading the books, you will still have one question which in unanswered: namely, Which moment is the present moment?

There is a sense in which the B-theorist thinks that this question has only a trivial answer: each time is present relative to itself, and no event is PRESENT, period, since no event has any A-series properties. But this seems odd. Doesn't our history leave out a genuine fact?

A third argument comes from a kind of asymmetry in our attitudes toward the future vs. the past:

We all know what it is to wait for something – an examination, for example; or coming home from the war; or Christmas. What we're waiting for begins by being future; it *hasn't yet* come to pass. Then a time comes when it does come to pass – when it's *present*, and we're aware of its presentness, and there's no mistaking it. And then it's past, and we say, perhaps, 'Thank goodness all that's over'; and we all know quite well what this 'being over' is, and couldn't mistake it for anything else.

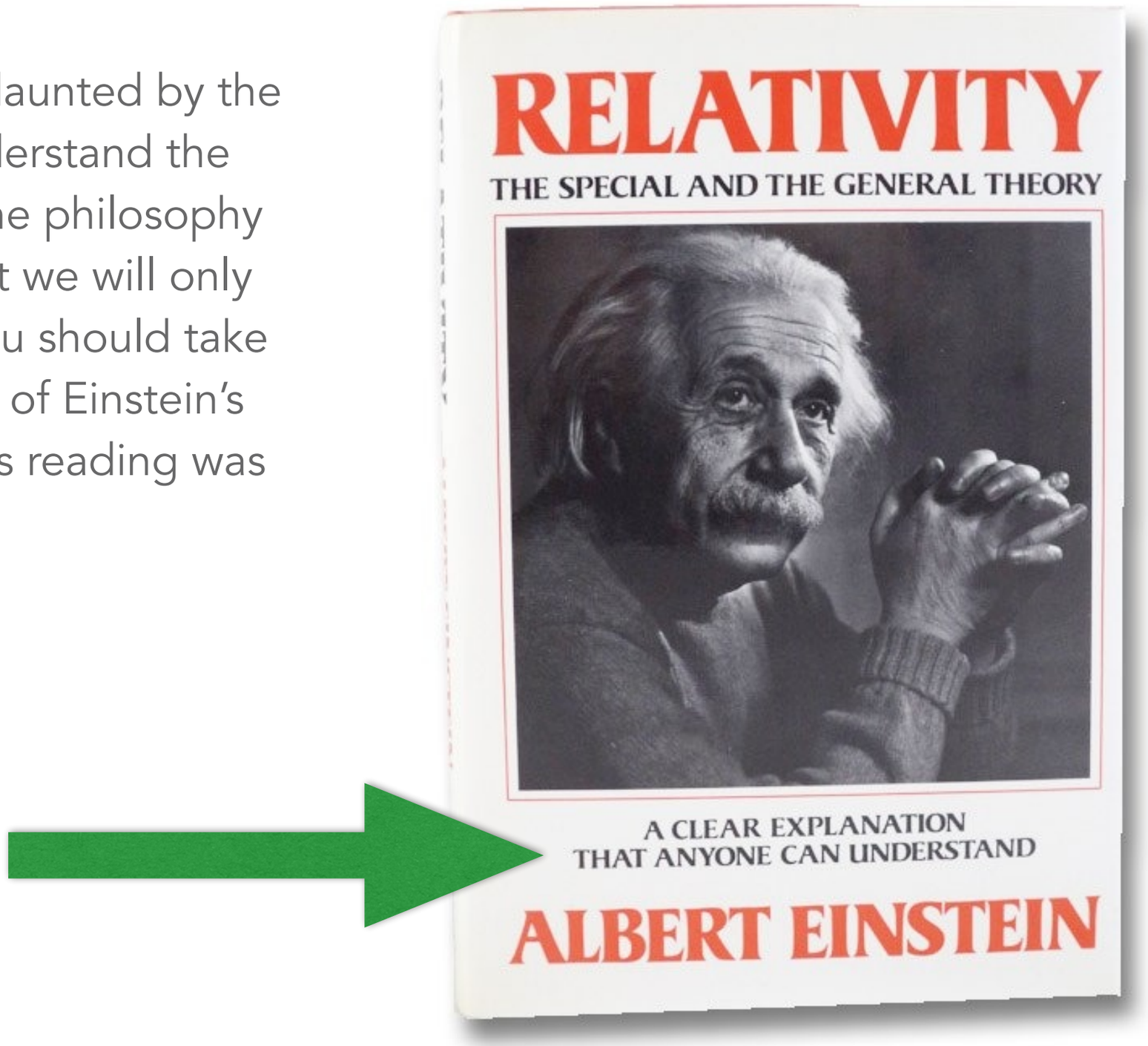
from Arthur Prior, "Some free thinking about time"

If there are no A properties, does it make sense to prefer that an unpleasant event be in the past rather than the future?

It is hard to see why it could. Yes, the unpleasant event is future relative to 2019; but it is also past relative to 2030. Why should one matter more than the other? You might be tempted to say: "Because it is 2019 now." But that is just to say that you believe that there are A properties.

This makes it all the more surprising that one of our best confirmed scientific theories, Einstein's special theory of relativity, seems to imply that there are no genuine A properties.

You may be somewhat daunted by the task of coming to understand the theory of relativity in one philosophy class. And it is true that we will only cover the basics. But you should take heart from the subtitle of Einstein's book from which today's reading was taken.



Einstein's theory arises from the following three plausible, but jointly inconsistent, claims:

Galilean relativity: the speed of x relative to y is the difference between their speeds if they're moving in the same direction, and the sum of their speeds if in the opposite direction.

The speed of light is a law of nature. (We'll follow convention by referring to this speed as "c".)

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Each of these claims seems quite plausible on its own. But, as Einstein points out, they can't all be true.

If a ray of light be sent along the embankment, we see from the above that the tip of the ray will be transmitted with the velocity c relative to the embankment. Now let us suppose that our railway carriage is again travelling along the railway lines with the velocity v, and that its direction is the same as that of the ray of light, but its velocity of course much less. Let us inquire about the velocity of propagation of the ray of light relative to the carriage. It is obvious that we can here apply the consideration of the previous section, since the ray of light plays the part of the man walking along relatively to the carriage. The velocity W of the man relative to the embankment is here replaced by the velocity of light relative to the embankment. w is the required velocity of light with respect to the carriage, and we have

$$w = c - v.$$

The velocity of propagation of a ray of light relative to the carriage thus comes out smaller than c.

Imagine that the guy is walking at speed v and the light is propagating at speed c. How does this situation bring out the contradiction between our three theses?

The contradiction is perhaps more obvious when we imagine the person walking in the direction opposite the propagation of the light.

Now how fast is the light going relative to our walker, if Galilean relativity is true?

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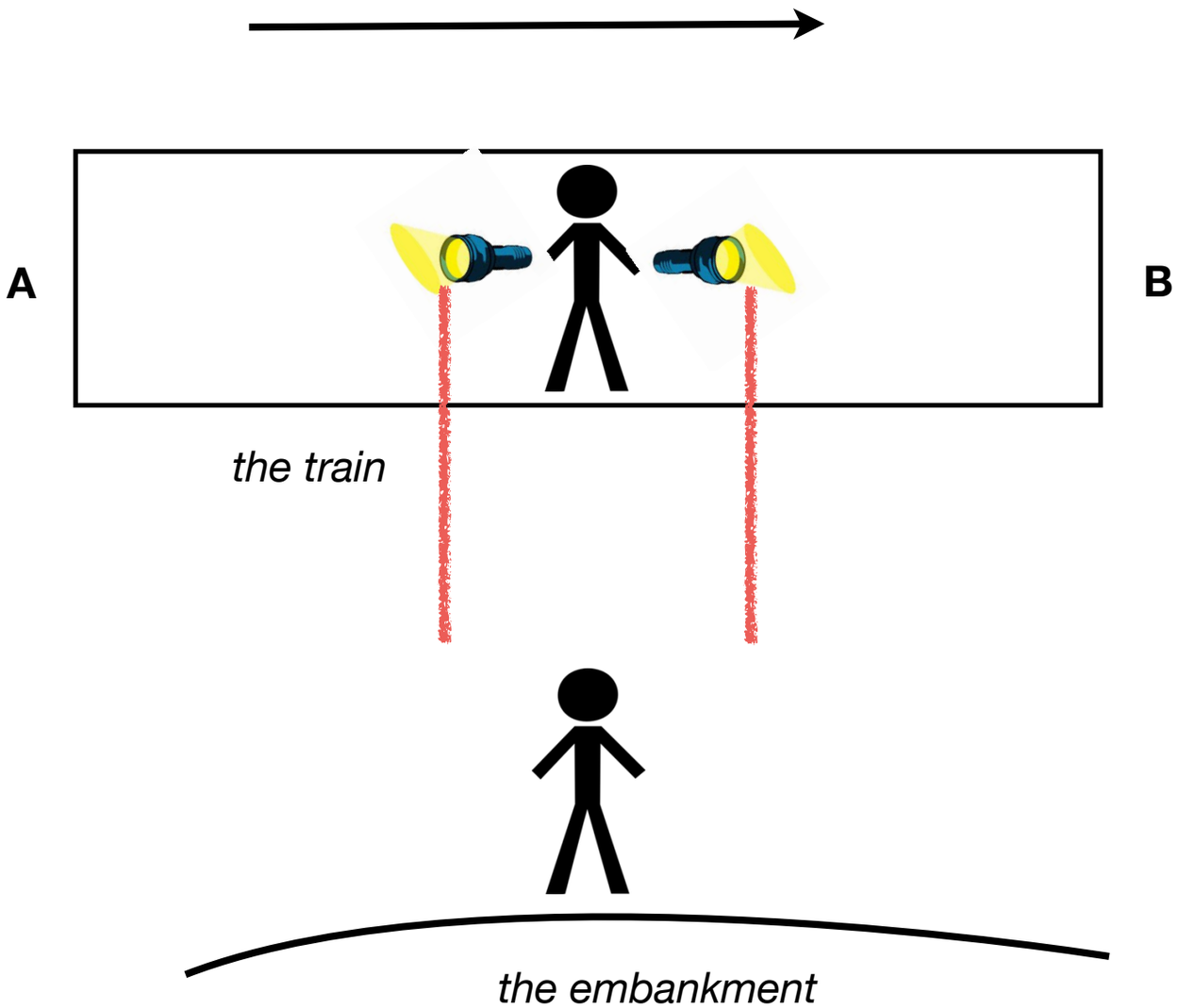
An initially plausible suggestion is that we should reject the claim that the speed of light is a law of nature, and say that the speed of light, like the speed of other things, can differ depending on one's speed relative to the light. But experiments designed to detect such differences in the speed of light failed to do so.

One of Einstein's innovations was to hold to the constancy of the speed of light while rejecting the principle of Galilean relativity. However, this idea has some surprising consequences, which can be illustrated by example. (The example I use follows one Einstein also used in presenting his theory.)

Imagine two people, one in a train moving at a constant speed from left to right, and one on an embankment watching the train go by. We can imagine that the train is made of glass, so that the person on the embankment can see in.

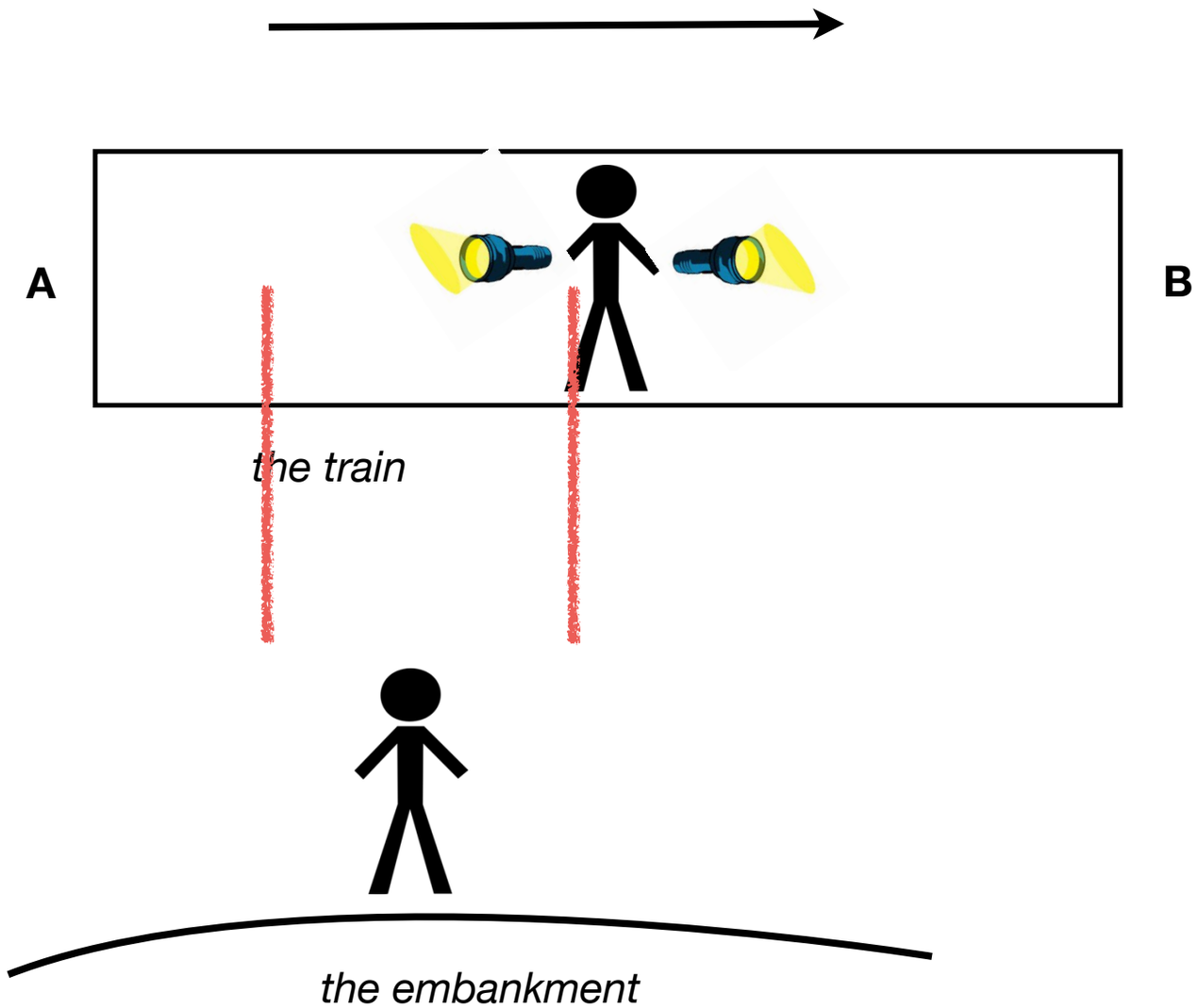


Now imagine that the person in the train car simultaneously turns on flashlights pointed at the two walls of the train car, A and B; and imagine further that he's at the exact midpoint of the train car.

Think about this situation first from the perspective of the person in the train car. Does the light reach A or B first?

But now think about this from the perspective of the person outside the train car. Do we get the same result?

Hence it seems, looked at from the point of view of the person on the embankment, the location at which the left flashlight was turned on was closer to the location at which the light hits A than the location at which the right flashlight was turned on is to the location at which the light hits B.



But, given that the speed of both beams of light is the same from every frame of reference — including the person on the embankment — it follows that from his point of view the light hits A before it hits B. And this is not an illusion, if the speed of light is genuinely constant between frames of reference.

Hence, it seems, the light's hitting A is simultaneous with its hitting B relative to the frame of reference of the train, but not relative to the embankment.

If simultaneity is relative to a frame of reference, so is duration. Consider the time between the flashlight being turned on and the beam of light hitting the back wall of the train car. This journey of the beam of light takes longer relative to the train car's frame of reference than relative to the frame of reference of the observer outside the train car.

The ordering of events can also change. Can you think of a variant of the above case in which one event happens before another from the perspective of the person on the train, but the ordering is reversed from the perspective of the frame of reference outside the train?

This is an extremely surprising result. We are accustomed to distinguish between facts which are dependent on a frame of reference or perspective, and facts which are not so dependent. We think of 'A is to the left of B' as in the first category, and 'A has more mass than B' as in the second category. One would have thought that 'A is before B' was in the second category — but if Einstein is right, this appears to be a mistake.

Suppose that Einstein's theory is true. Are B properties, like being earlier than something, real?

It seems that they are real only relative to a frame of reference: it might be genuinely (and permanently) true that X is earlier than Y relative to one inertial frame (but false relative to another). So B properties are significantly reconfigured by Einstein's theory.

How about A properties, like being past, present, or future?

Suppose that two people pass each other in the street. Let t be the time at which they pass. What things have the A property of being present, at the moment at which they pass?

The obvious answer is: the things which exist simultaneously with the event of their passing each other.

The problem is that different events and things will be simultaneous with this event, depending on which person's frame of reference we pick. And to pick either person #1's or person #2's frame of reference as the one corresponding to the present appears to be worryingly arbitrary.

You might think that we can still have properties like 'present relative to this event.' But is that an A property or a B property?

On the picture of spacetime given to us by the theory of relativity, there appears to be no obvious place for A properties. But this suggests that our ordinary, and deeply held, view that there is a genuine, objective distinction between past, present, and future, is just an illusion.

If we give up on A properties, it seems that we also have to give up on the idea that time passes, or moves.

Intuitively, the idea that time passes is the idea that which time is the present time changes over time. But that would require the existence of A properties.

Interestingly, the idea that time moves is itself a bit paradoxical. It seems that if time moves, it must move at some speed or other. But what speed would it move at? 1 second per second?

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Here is a short argument that time travel makes no sense. Let's imagine a case of time travel into the future. Suppose that you construct a time travel machine designed to take you to the year 2100. How much time passes between the time when you get into the time travel device and the time when you get out?

Answer 1: 81 years, because there are 81 years between 2019 and 2100.

Answer 2: less than 81 years — after all, you are a time traveler, and so can move more quickly between 2019 and 2100 than someone who is simply living out the years in between these two times.

Which answer is right? It seems that both must be — but that is a contradiction.

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It seems that, in a way, both are right. It is of course true that 81 years pass between 2019 (when you enter the machine) and 2100 (when you get out). But it also seems true that less years pass for you.

One way to make sense of this is to distinguish between personal time and external time.

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This helps us to understand what time travel would be. Time travel would be (as a first approximation) a case in which your personal time differs from external time.

We can then distinguish two different kinds of time travel.

First, you could time travel into the future. This would be a case in which some number N of years of external time pass between getting in the time machine and getting out, and some number <N of personal time pass.

Second, you could time travel into the past. This would be a case in which the "passage" of years of external time is negative, and the time in personal time is positive.

Does either make sense?

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Does either make sense?

Time travel into the future not only makes sense, but has already been accomplished. It follows from the theory of special relativity that someone who leaves earth on a spaceship and returns will have time traveled into the future — less of their personal time will have passed than has external time.

Given current technology, the difference is a matter of milliseconds; more significant differences would require spaceships that travelled much closer to the speed of light than the slow moving ones we can manage now. But there is nothing in principle impossible or difficult to understand about the idea that someone could set forth in such a super-fast spaceship and return to an Earth quite far into its (external) future.

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A first question is: does the theory of relativity allow for the possibility of time travel into the past?

The simple answer is: yes. The general theory of relativity is consistent with the existence of wormholes, which can be thought of as “shortcuts” between different points in spacetime — which may be, otherwise, quite distant.

It is controversial whether wormholes exist, or could be made to exist, in our universe. Even if they could, they may be subject to limitations of certain kinds.

But let’s suppose that wormholes could exist in our universe. Could we use them to time travel into the past?

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Let's set aside any physical reasons why this would not work — for example, limitations on the size of things that could travel through wormholes — and ask whether there are any philosophical reasons for thinking that this would not make sense.

There are two main philosophical arguments against backwards time travel.

The first is that, if backward time travel were possible, this would permit the possibility of causal loops.

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Suppose that I time travel back to 1985. Then the event of me getting into the time travel machine in 2019 is the cause of me emerging in 1985. Of course, the event of me getting into the time travel machine in 2019 must have had some cause; and this will typically be something that happened prior to 2019. But it might, for all we have said, be causally dependent in something I did in 1985, after my time travel. That would be a causal loop.

Here's an example from the reading for today:

> In 1971 Jimmy Hoffa is pardoned by President Nixon and released from jail. In 1975 Nixon reminds Hoffa that he owes him $300,000 for the pardon. Hoffa goes to see a mafia boss by the name of Anthony "Tony Pro" Provenzano. (As we will see in a minute, "Tony Pro" in fact just is Hoffa's older self.) "Tony Pro" gives Hoffa the $300,000 he needs. Hoffa hands the money over to Nixon, and gets into a time machine (provided to him by the Republican Party), so that he mysteriously disappears from the public eye. Hoffa travels back to 1964 and starts calling himself Anthony "Tony Pro" Provenzano. "Tony Pro," with the cooperation of Hoffa, manages to get the Teamsters union under the control of organized crime. "Tony Pro" agrees to pay Hoffa $300,000 in reward for his help. Later on in 1964 Hoffa is arrested and convicted of having illegal connections with organized crime. Eleven years later "Tony Pro" pays off his debt to Hoffa, and "Tony Pro" lives happily ever after.

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Does this story make sense?

On the one hand, if backward time travel makes sense, it is hard to see why this would not make sense.

On the other hand, we have here a kind of puzzling circular explanation. Hoffa enters time machine in 1975 → "Tony Pro" emerges in 1964 → Tony Pro reaches $300K agreement with Hoffa → in 1975 Tony Pro pays Hoffa $300K → Hoffa enters the time machine in 1975 → …

The second argument against backward time travel is a kind of paradox known as the grandfather paradox.

Suppose that you could travel back in time. Then presumably you could travel back in time to some point during the life of your grandfather. And presumably, if you were so inclined, you could kill your grandfather. But, presuming that you visited your grandfather at a time in his life prior to the conception of your parents, your so doing would prevent your being born. But then you would not have gone back in time to kill your grandfather.

We can lay this out explicitly as an argument, as follows:

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1. Time travel is possible.
2. If time travel is possible, I can travel back in time and kill my grandfather in 1920.
3. I can travel back in time and kill my grandfather in 1920. (1,2)
4. If I kill my grandfather in 1920, my grandfather dies in 1920.
5. If my grandfather dies in 1920, I am never born.
6. I can travel back in time and bring it about that I am never born. (3,4,5)
7. If I am never born, I can never time travel.
8. I can travel back in time and bring it about that I never time travel. (6,7)

———————————————————

C. Possibly, I travel back in time and never time travel. (8)

The conclusion of the argument is clearly false. So at least one independent premise must be false. Which one is it?

The tempting idea is that if we could go back in time, then surely we would then as now be free to do what we want; and surely this means that it is genuinely possible for us to do things we have the opportunity to do, such as killing our former selves. But this is not possible; hence either time travel must not be possible, or there would be some sort of odd asymmetry between our free will now and our free will post-time travel, or our views about the nature of our freedom of the will must be mistaken.